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Marine Fisheries REVIEW

National Oceanic and Atmospheric Administration • National Marine Fisheries Service

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Marine Fisheries Review

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Possible Anomalies of Giant Bluefin Tuna

HOWARD A. SCHUCK

INTRODUCTION

Recently, observers collecting Atlantic bluefin tuna, *Thunnus thynnus thynnus*,[1] data have contended that they have seen some bluefin tuna that differ markedly in form and bodily proportions from the bulk of the fish observed.

These fish were first reported by Raimondo Sara who noted that some of the fish landed in Italy in the 1974 season appeared "strange" (Frank J. Mather, pers. commun., 10 June 1974, see Appendix). He believed that such fish possessed unusually long second dorsal, anal, and pectoral fins, and were heavier in relation to their length. They were all extremely large fish: From 250 to 260 cm in length, and weighing from 362 to 485 kg (796-1,067 pounds).

Sara posed possible theories as to the identity of these strange tunas. He wondered if they could be: 1) Another species—yellowfin (*Thunnus albacares*), bigeye (*Thunnus obesus*), etc.?; 2) A modification of *Thunnus thynnus thynnus* (a subpopulation not heretofore present in the Mediterranean?); 3) or perhaps merely a function of size (and thus not noticed earlier because fish of these large sizes were not often taken).

Without knowing of the Mediterranean June 1974 observations, Linda Despres of the Northeast Fisheries Center (NEFC), while measuring bluefin tuna at Bailey Island, Me., in July 1974, noticed that some of these fish seemed to differ in appearance from normal fish in that they had distinctly longer second dorsal and anal fins. She was not impressed that pectorals were also longer, or that these fish were fatter than normal. She reported that some fishermen believed that there were two different "types," and that the longer-finned type first appeared a couple of years ago. They were also of the opinion that this type was more often taken by harpoon than by hook and line. There was another theory—that the "long-fin" were of one sex, the "normal" fish of the other.

THE PROBLEM STATED

In response to the interest generated by these observations, it was decided that answers to the following questions should be sought.

1) Is there a group of large bluefin tuna in the North Atlantic or Mediterranean that differs significantly with respect to fins or other characteristics (such as relative heaviness) from "normal" fish? Or, are these observations of an "abnormal" type spurious? For instance, could they represent merely the longest of a graduated spectrum of fin lengths ranging from relatively short to relatively long—i.e., the result of normal biological variation, that is found to some degree in all species and for all parameters?

2) Do bluefin tuna at present (1974) have significantly longer fins, or other characteristics (like relative weight) significantly different from fish measured in earlier years?

3) If the answer to either 1 or 2 is "Yes," then what hypothesis seems reasonable to explain these differences?

THE DATA

The data available to the author for resolving the above questions are described in the following paragraphs.

Western Atlantic

1. Bailey Island, Me., 23-27 July 1974

Linda Despres of the Northeast Fisheries Center (NEFC) measured most of the tuna landed during the Bailey Island Tournament held 23-27 July 1974. After noticing an unusual "type," characterized mostly by relatively long second dorsal and anal fins, she classified 40 fish into 2 categories. Twenty-three were classified as appearing to possess a "regular" fin and 17 as appearing to possess a "long (or sickle) fin." No fins were measured, but two second dorsals (one long, one regular) were cut off and brought to Woods Hole where they were subsequently measured by Schuck and F. J. Mather, III.

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[1]For a description of the species and its characteristics, see Gibbs and Collette, 1967 and Mather, 1964.

She also photographed another long fin (Fig. 1) and another regular fin (Fig. 2) and provided these to the author. However, no photointerpretation technique has been found to validly estimate the actual (or relative) lengths of these two fins. Thus, the only "long fin" second dorsal for which we have a measurement (of fish landed at Bailey Island during the Tournament) is the preserved one which measures 50 cm. The fork length of this fish was 246 cm. The single "regular" second dorsal measures 36 cm, and is from a fish of 239 cm. These two samples were from a total landing of 73 fish during the 5-day period.

A great deal of other information was also collected on some of the 73 fish landed, i.e. sex, how caught, weight and length (thus lg-wt)—much of it subjectively divisible into "long fin" vs "regular fin" groups. Table 1 provides a summary of the Bailey Island Tournament data.

Table 1.—Data from Bailey Island Tournament, July 1974.

Length (inches)	Wt. (lb)	Sex	Gear
"Regular fin"			
103.25	720	M	B[1]
105.50	673	M	B
97.00	603	F	B
101.50	586	M	HP[2]
100.25	603	M	B
96.50	587	—	HP
100.25	594	—	HP
107.00	740	—	HP
101.00	673	M	HP
107.75	696	M	HP
100.50	643	M	B
97.00	563	M	B
104.25	672	M	HP
102.50	620	M	HP
103.25	712	M	HP
103.00	650	M	HP
101.25	664	F	HP
96.75	527	F	HP
104.00	786	M	HP
94.00	525	—	B
99.50	634	—	B
107.75	733	—	HP
94.00	508	—	HP
"Long fin"			
91.25	561	F	B
101.25	625	F	B
106.25	684	M	HP
96.25	671	—	HP
100.25	627	—	HP
102.00	718	M	HP
105.75	741	F	HP
110.50	711	F	B
99.00	572	M	HP
106.50	713	M	HP
103.75	723	M	HP
101.25	677	—	HP
101.75	781	—	HP
102.00	672	M	HP
103.00	670	—	HP
97.00	610	—	HP
96.75	532	—	B

[1]Bait
[2]Harpoon

2. Gloucester, Mass., 23 Sept.-1 Oct. 1974

A presumably "random" sample of 33 fish landed at Gloucester for the fishing season up to 1 Oct. 1974, was provided by Peter Wilson on 7 October (Table 2).

Figure 1.—"Long-finned" second dorsal selected by Despres.

Figure 2.—"Regular" length second dorsal selected by Despres.

3. Gloucester, Mass., 2-11 Oct. 1974

A second "random" sample of Gloucester-landed fish (30 fish for the period 2 Oct. through 11 Oct. 1974) was provided by Peter Wilson at the end of the season (Table 3).

Table 2.—Data[1] from Gloucester, Mass., 23 Sept.-1 Oct. 1974.

Spec. no.	Date	Fork L. (curved lg.)	P. Dor. L. (tape)	2nd dorsal	Anal	Wt-Rnd (lb)	Sex
1	9/23	245	183	37	33	—	F
2	9/26	274.5	192	34	39	710	F
3	9/26	255.3	189	44.8	[2]32.3	755	F
4	9/26	259.5	193.5	39	40.3	810	M
5	9/26	266	191	39.7	42.5	725	M
6	9/26	245.5	177	41.5	41	655	F
8	9/27	255	187	42.5	44.5	655	F
9	9/27	264	195	44	39	830	M
10	9/27	259	191	43	41	670	F
11	9/27	270	200	50.5	43.5	770	M
12	9/27	225.5	163.5	36.5	38.5	470	F
13	9/27	253	182	41	38	630	F
14	9/27	273	196	38.5	44	760	F
15	9/27	270	197.5	40.5	41	785	M
16	9/27	268	198	41.5	41.5	785	F
17	9/27	281	201.5	49	45	845	M
18	9/27	219	165.5	34	33	425	M
19	9/27	270.5	196.5	44	43	695	M
20	9/27	277.5	204	41.5	41.5	820	M
22	9/28	248	—	41.5	39	645	F
23	9/28	254	—	40.5	41.5	650	M
24	9/28	274.5	—	37	35.5	770	F
25	9/28	282	—	42.5	40	790	M
26	9/28	257	184.5	38.5	36	675	F
27	9/28	226.5	162.5	35	35	560	M
28	9/28	276.5	198	45	43.5	830	F
29	9/29	263	187.5	42	[2]30.5	760	M
30	9/29	274	196	[3]56	36	795	M
31	9/29	272	199	41	43.5	810	M
32	10/1	261.5	190.5	41	39	755	M
35	10/1	228	162.5	37.5	31	450	M
36	10/1	251.5	—	38.5	38.5	625	F
37	10/1	277	195.5	46.5	41.5	780	M

[1]All lengths are in centimeters.
[2]Damaged
[3]Preserved

Table 3.—Data[1] from Gloucester, Mass., 2-11 Oct. 1974.

Date	Fork length (curved lg.)	2nd dor-sal	Anal	Round wt. (lb)	Sex
10/2	277	43.0	41.5	880	M
10/2	269	[2]57.0	[2]47.5	705	M
10/2	251	35.5	35.0	685	F
10/3	254	35.5	37.0	610	F
10/3	270	42.0	46.0	800	M
10/3	247	40.0	42.0	695	F
10/3	267	[3]39.0	41.0	775	F
10/3	274	49.5	43.0	825	M
10/3	275	39.0	39.0	875	M
10/4	244.5	35.5	33.0	635	F
10/5	274	39.5	38.0	815	F
10/5	260	39.0	42.0	700	F
10/5	267	38.0	37.5	735	F
10/5	275	41.5	42.5	785	M
10/6	260.5	[2]49.0	[2]46.0	735	F
10/6	269	49.5	46.5	775	F
10/6	275.5	[2]51.5	[2]50.5	845	M
10/7	270	42.0	43.5	780	M
10/7	264	36.5	35.5	—	M
10/8	257.5	44.5	38.5	670	M
10/8	276	36.0	37.5	715	M
10/8	261.5	42.0	[3]36.0	835	M
10/8	290.5	44.5	38.0	840	M
10/10	273.5	47.0	46.5	900	M
10/10	290	39.5	39.0	885	M
10/10	201	26.0	25.5	280	F
10/11	221	34.5	29.5	410	F
10/11	256.5	40.5	38.5	—	M
10/11	272	53.0	49.5	—	M
10/11	265.5	35.0	36.0	790	M

[1]All lengths are in centimeters.
[2]Preserved frozen
[3]Damaged

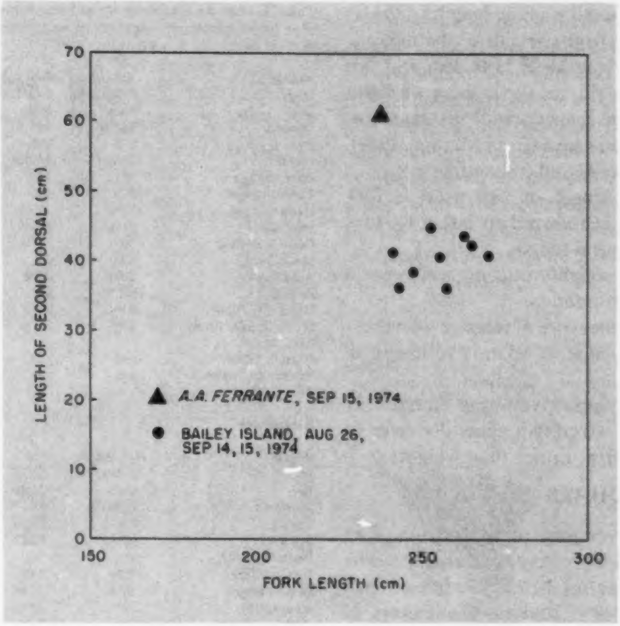


Figure 3.—Data of 10 fish provided by SEFC.

4. Prince Edward Island, 2-4 Oct. 1974

From 2-4 Oct. 1974, Fred Nichy of NEFC was stationed at Prince Edward Island at the request of Southeast Fisheries Center (SEFC) to obtain measurements of 31 tuna landed there during that period. Second dorsals were measured along with many other parameters. These data, which can also be considered as a "random" sample, are shown in Table 4.

5. Bailey Island, Me., August, September; *A. A. Ferrante*

From SEFC, graphical data were received representing total length and length of second dorsal of 10 tuna, 9 of which were measured at Bailey Island, Me., 26 August and 14 and 15 September. Presumably these can be considered as a random sample. The tenth plotted point was for a single fish out of the total catch of 60 tons taken by the U.S. purse seiner *A. A. Ferrante* in September. Reportedly no other fish of this large catch was measured. It must therefore be considered as a selected sample. This one "measurement" indicates a very long second dorsal fin (61 cm is our interpretation of the graphed point, from a fish of about 238 cm total length). These original data are shown in Figure 3.

European Waters

From Frank Mather's translation of Sara's 10 June 1974 letter (Appendix) and subsequent telephone calls and notes to Sara by Frank Mather, it appears that:

1) While the total number of fish in the 1974 Italian trap catch was extremely small[2], the fish taken were exceptionally heavy (with "averages peaking at 880 pounds").

2) Not only were the fish extremely large, but they included individuals of unusual body proportions (very heavy in relation to their length, and with noticeably longer pectoral, second dorsal, and anal fins).

3) At Favignana five of these "strange" fish were measured. They ranged from 250-260 cm in total (fork) length, and had weights of 485, 479, 406, 362, 461 kg (1,067, 1,053, 893, 796, and 1,014 pounds). Their second dorsals ranged from 53 to 55 cm, anals from 52 to 54, and pectorals from 48 to 50.

4) Apparently, only the 5 "strange" fish were measured—out of 2,080 fish landed. They were seemingly picked as examples of the "strange-looking" fish, and must be considered as a nonrandom sample.

5) Supplementing Sara's earlier transmissions, Frank Mather received a 29 Jan 1975 communication from Sara. He stated that the "strange" tunas perhaps amounted to 12-15 percent of the total landed. He provided photographs of two of these fish, which I have reproduced with Frank Mather and Sara's permission as Figure 4.

6) Finally, Frank Mather received in December 1974 a report by a Canary Island fisherman of a tuna of 497 kilos (1,094 pounds) that was apparently so heavy for its length that it was classified by its captors as a "bigeye" tuna (*Thunnus obesus*).

[2]Revised 1974 totals for the Italian traps were given by telephone on 9 Oct. 1974, to be: Favignana, 2,080 fish; Formica, 580 fish; Bonagia, 290 fish; Sardinia, none.

DEFINITIONS

1) The fin used to represent the "longfin" phenomenon was the second dorsal fin, inasmuch as it had been measured most often by 1974 observers.

2) The measure of "relative"

fin-length used was the length of the fin in relation to the length of the fish.

3) The lengths of both fish and fins utilized in this analysis were straight-line (rather than curved) distances, as shown in Figure 5 (from Mather, 1964), and are expressed in centimeters.

4) The length of fish used is fork length. It is referred to either as fork length or total length.

5) The weights utilized were round weights, in pounds.

6) The measure of relative heaviness was the weight in relation to length of fish.

7) The subjective terms "larger" or "smaller" sized fish generally refer to length of fish, rather than weights.

PROCEDURES

1) Conversions of the original data were made where necessary. The straight-line total (fork) length of each fish was estimated in centimeters in cases where original data were provided in inches or were curved lengths (measured by tape around the curvature of the body). As provided by Frank Mather, this formula was used: $0.958X = Y$, where X = curved fork length, Y = straight-line fork length[3].

2) The resultant standardized values of all available Western Atlantic 1974 fin data received for this analysis, is presented in Table 5. It is to be noted that these 106 fish contain 103 that can be considered as random samples: 33 from Gloucester in September, 30 from Gloucester in October, 31 from Prince Edward Island and 9 from Bailey Island in August and September. It also includes 3 that must be considered as selected and non-random (2 from Bailey Island in July—1 "long fin," 1 "regular fin;" 1 from the purse seiner *A. A. Ferrante*).

3) The European 1974 fin data were summarized as 5 fish of 250 to 260 cm fork length with second dorsals ranging from 53 to 55 cm.

4) Perusal of the literature turned up the fact that the relationship between length of second dorsal and length of fish is not a straight line, but is curvilinear, with larger fish having rela-

[3]Also, weights were converted, where necessary, from kilograms to pounds (kg = 2.2 pounds).

Table 4.—Bluefin tuna data, North Lake, Prince Edward Island.

Sample No.							
Vessel	*Aquarius*	*Bee Jay*	*Scott's Pride*	*Lucky Strike*	*Seawood*	*Bessie Keefer*	*Lucky Dawn*
Date	2 Oct. 74	2 Oct. 74	2 Oct. 74	2 Oct. 74	2 Oct. 74	2 Oct. 74	2 Oct. 74
Sex	Male	Male	Male	Male	Male	Male	Male
Weight	758 lb	901 lb	845 lb	769 lb	850 lb	900 lb	890 lb
Fork L.	8′5″	8′8″	8′10½″	8′4″	8′8¾″	8′8¾″	8′6″
Flank L.	104½″	109½″	112¼″	108¼″	108″		
Pectoral Fin L.	15″	18½″	17¼″	17″	17″	17⅞″	17⅞″
Dorsal Lobe	21″	18″	15 3/16″	18½″	18″	15¾″	15¾″
Head Length	27¾″	27½″	28⅝″	27 11/16″	27¾″	28⅝″	28″
Max. Depth	27½″	29¾″	29¼″	28¾″	28½″	29⅜″	29″
Caudal Spread	36″	35½″	35⅞″	35″	34¼″	34⅞″	34⅜″
Max. Girth	82″	81″	77½″	77″	80″	79½″	79″
Anal Depth	20⅜″	22¾″	22⅛″	21″	22″	22⅛″	22″
Anal Girth	52″	61″	56″	55¼″	59″	60″	62″
D1 to 6th Finlet	51″	56¾″	59½″	56¼″	54½″	59½″	
D1 to Caudal Fork	6′3″	6′7¾″	6′7¾″	6′6¾″	6′5″	6′4¾″	
Max. Width							
Muscle Taken	yes	yes	yes	yes	yes	yes	yes
Vertebrae Taken	yes	yes	yes	yes	yes	yes	yes
Anal Width							

Sample No.							
Vessel	*Red Baron*	*Liz*	*Lynell Jane*	*Spray Boy*	*Wendy R.*	*Morag*	*Sheryll & Tammy*
Date	2 Oct. 74	2 Oct. 74	2 Oct. 74	2 Oct. 74	2 Oct. 74	3 Oct. 74	4 Oct. 74
Sex	Male	Male	Male	Male	Male	Male	Male
Weight	1,020 lb	867 lb	725 lb	899 lb	840 lb	914 lb	845 lb
Fork L.	9′4″	8′5¼″	7′10″	8′9″	9′1″	9′1″	8′4½″
Flank L.	117″	108″	101½″	114½″	113″	115½″	108½″
Pectoral Fin L.	21″	16″	16½″	17⅝″	17¼″	17⅛″	19″
Dorsal Lobe	18½″	14½″	14⅝″	19¾″	18½″	20″	18″
Head Length	28½″	27¼″	24 11/16″	26⅝″	27″	29½″	27⅝″
Max. Depth	31″	29½″	28″	28 9/16″	27½″	29 1/16″	29¼″
Caudal Spread	39″	39½″	31″	39¾″	36″	34″	36″
Max. Girth	84″	80″	75½″	79½″	77½″	82½″	79″
Anal Depth	24″	22½″	21 3/16″	21″	19½″	21 13/16″	22½″
Anal Girth	61″	62″	58″	56⅛″	51½″	57½″	60″
D1 to 6th Finlet	60″	54″	51⅞″	59½″	60¼″	60¾″	54½″
D1 to Caudal Fork	6′11″	6′2″	5′11″	6′9½″	6′11″	6′9¼″	6′2″
Max. Width							
Muscle Taken	yes	yes	yes	yes	yes	yes	no
Vertebrae Taken	yes	yes	yes	yes	yes	yes	no
Anal Width							

Sample No.					
Vessel	*Gulf Queen*	*Clayton D.*	*Steven K.*	*Bessie Keefer*	*Sheryll & Tammy*
Date	4 Oct. 74	4 Oct. 74	4 Oct. 74	4 Oct. 74	4 Oct. 74
Sex	Male	Male	Male	Male	Male
Weight	853 lb	985 lb	856 lb	840 lb	750 lb
Fork L.	8′5½″	9′1¾″	8′10½″	8′5½″	8′3″
Flank L.	106″	113¼″	112″	106″	103″
Pectoral L.	18½″	18⅜″	17½″	18¼″	16¾″
Dorsal Lobe	14½″	19½″	16½″	16½″	16″
Head Length	27⅝″	28½″	26¾″	27¾″	27⅛″
Max. Depth	28⅜″	30¾″	28¾″	28¾″	27¾″
Caudal Spread	33⅞″	37¼″	35″	36″	32″
Max. Girth	80″	84½″	78″	79″	76″
Anal Depth	22⅝″	24¼″	20¾″	21¾″	21½″
Anal Girth	61½″	62″	54½″	59″	56″
D1 to 6th Finlet	56½″	59¾″	53″	55¼″	54″
D1 to Caudal	6′4⅝″	6′9⅝″	6′7″	6′2½″	6′½″
Max. Width					
Muscle Taken	yes	no	yes	no	yes
Vertebrae Taken	yes	no	yes	no	yes
Anal Width	14¾″				

Sample No.					
Vessel	*Cape Light*	*Bay Lady*	*Clayton D.*	*Best O Luck*	*Aquarius*
Date	4 Oct. 74	4 Oct. 74	4 Oct. 74	Oct. 74	4 Oct. 74
Sex	Male	Male	Female	Male	Male
Weight	921 lb	859 lb	696 lb	865 lb	930 lb
Fork L.	8′6″	8′4¾″	8′1″	8′6½″	8′7⅝″
Flank L.	107″	103½″	98¼″	107½″	109¼″
Pectoral Fin L.	15½″	17½″	16″	18″	18¾″
Dorsal Lobe	17½″	16¾″	14″	16¼″	16½″
Head Length	26″	27⅛″	26½″	27″	27½″
Max. Depth	29¾″	28″	26⅛″	29⅝″	30¼″
Caudal Spread	34″	35½″	32½″	36″	35″
Max. Girth	80″	78″	76″	80″	83″
Anal Depth	23¾″	21⅝″	20 1/16″	20⅝″	23″
Anal Girth	65″	63″	58″	60″	62″
D1 to 6th Finlet	56″	53½″	50¼″	51″	53⅝″
D1 to Caudal Fork	6′6″	6′2⅜″	5′10⅜″	6′3″	6′1″
Max. Width				21⅝″	
Muscle Taken	no	yes	yes	yes	yes
Vertebrae Taken	no	yes	yes	yes	yes
Anal Width					

Table 4.—Bluefin tuna data (cont'd).

Sample No.							
Vessel	*Aquarius*	*Morag*	*I'm Alone*	*Bee Jay*	*Morag*	*Patricia Irene*	*Troy B.*
Date	4 Oct. 74	4 Oct. 74	4 Oct. 74	4 Oct. 74	4 Oct. 74	4 Oct. 74	4 Oct. 74
Sex	Male	Female	Male	Female	Female	Male	Male
Weight	800 lb	790 lb	710 lb	640 lb	721 lb	901 lb	712 lb
Fork L.	8′6⅝″	8′3″	8′7⅝″	7′10½″	8′2¼″	8′10″	8′1″
Flank L.	109¼″	106⅞″	110⅜″	99⅝″	103⅝″	110½″	
Pectoral L.	16⅜″	16¼″	19½″	16¼″	19¾″		18″
Dorsal Lobe	17⅜″	19⅜″	22⅜″	16¼″	16¾″	16⅜″	16½″
Head Length	28⅛″	27″	28$^{1}/_{16}$″	24″	25⅝″	29$^{5}/_{16}$″	25¼″
Max. Depth	29⅜″	27½″	27⅛″	24⅝″	25¾″	29⅝″	27″
Caudal Spread	36¼″	32¾″	35⅜″	30⅜″	32″	33¾″	31″
Max. Girth	78½″	78″	73″	70″	72″	79″	74″
Anal Depth	21$^{9}/_{16}$″	20$^{7}/_{16}$″	18½″	20¾″	20″	22⅛″	21½″
Anal Girth	57½″	59¼″	48½″	55½″	55½″	58½″	59″
D1 to 6th Finlet	55⅝″	50″	55½″	35⅜″	54⅜″	58¼″	54⅞″
D1 to Caudal	6′4¾″	6′⅝″	6′5⅝″	5′11¾″	6′1⅝″	6′7¼″	6′1½″
Max. Width	20⅛″	21½″		19$^{11}/_{16}$″	19⅝″	21$^{5}/_{16}$″	19¼″
Muscle Taken	yes	yes	yes	yes	yes	yes	yes
Vertebrae Taken	yes	yes	yes	yes	yes	yes	yes
Anal Width	15¾″	17⅛″		13⅜″	17$^{5}/_{16}$″	17″	15½″

tively longer second dorsals than smaller fish[4]. Thus, the simplifying use of relative size of second dorsal (i.e., relative to the length of the fish) by either percentage or ratio of one part to the other was generally ruled out. Any comparison of ratios or percentages for groups of fish that are not almost exactly of the same size will introduce an artificial error that could lead to unwarranted conclusions.

[4]See Figure 6, from "A Preliminary Report on Biometrical Studies of Tunas (Genus *Thunnus*) of the Western North Atlantic," by Frank J. Mather, III, WHOI, Woods Hole, Mass., June, 1959.

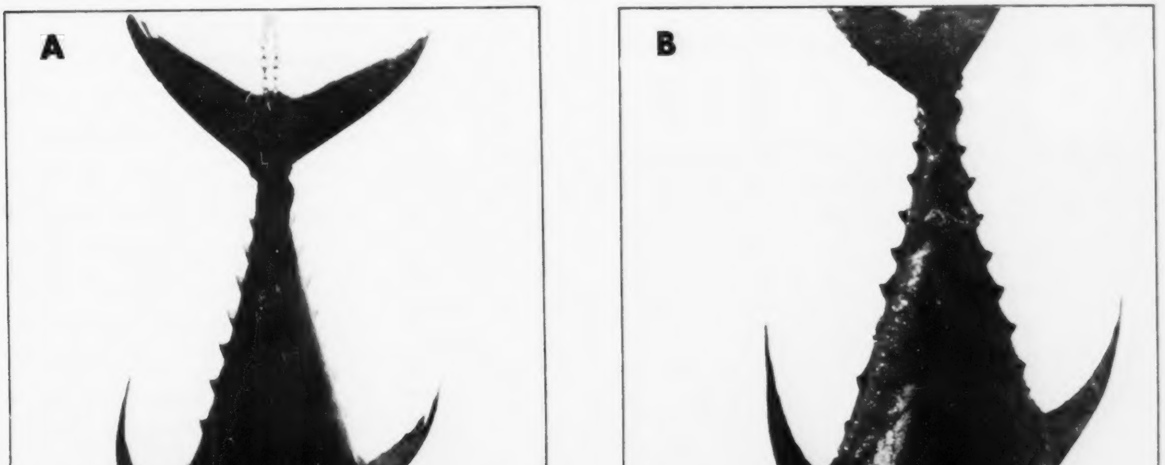


Figure 4.—Two of Sara's "unusual proportioned" tuna.

In addition, the relationship between fish length and weight is highly curvilinear, as would be expected.

Thus, the use of two-value regression analysis was dictated, rather than the convenient use of single-value ratios or percentages of one body parameter to another.

5) Another factor affecting the type of analysis was the nonrepresentativeness of the data. In all three cases where "abnormal" fish were thought to be perceived, these and only these fish were measured, and the rest of the landings were not measured for the observed characteristic. This is true for the one "long fin" measurement of Despres (of 73 fish landed), of the one "long fin" measured by SEFC personnel (of 60 tons landed), and even of the five European fish of Sara (of 2,080 fish). These samples must be treated as selected samples. And without knowledge of the length of fins (and other characteristics) of the rest of the population from which these samples were drawn, one will be limited in the conclusions that may be drawn.

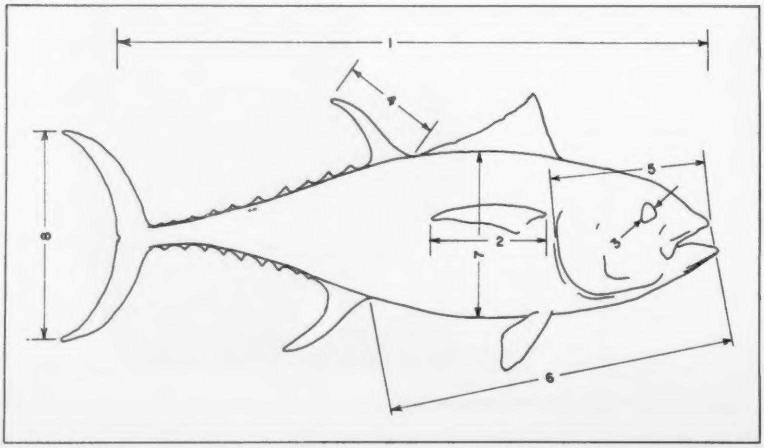
6) In view of the paucity of 1974 data available, visual inspection of plotted regressions was deemed adequate, rather than transformations and then least squares regression or covariance analysis.

7) Within the constraints of quality and quantity of data available, the following section attempts to glean all that appears warranted from the existing data.

Table 5.—Summary of available 1974 data on relative fin lengths.

Place, date	Fork lg. (cm)	2nd dorsal (cm)	Place, date	Fork lg. (cm)	2nd dorsal (cm)	Plate, date	Fork lg. (cm)	2nd dorsal (cm)
Bailey Isl.	246	[1]50.0		240	35.5		277	47.0
July 1974	239	[1]36.0		243	35.5		277	51.0
				259	42.0		255	46.0
Gloucester	235	37.0		237	40.0		258	37.0
23 Sept.-	263	34.0		256	39.0		279	49.0
1 Oct.	244	44.8		262	49.5		271	42.0
	249	39.0		263	39.0		258	42.0
	255	39.7		234	35.5		251	41.0
	235	41.5		262	39.5		259	44.0
	244	42.5		249	39.0		256	43.0
	253	44.0		256	38.0		246	36.0
	248	43.0		263	41.5		260	41.0
	259	50.5		250	49.0		263	42.0
	216	36.5		258	49.5		261	44.0
				264	51.5			
	243	41.0		259	42.0		251	49.0
	262	38.5		253	36.5		263	57.0
	259	40.5		247	44.5		240	41.0
	257	41.5		264	36.0		250	43.0
	269	49.0		251	42.0		269	42.0
	210	34.0		278	44.5		246	42.0
	259	44.0		262	47.0			
	266	41.5		278	39.5	*A. A. Ferrante*	[1,2]238	[1,2]61.0
	238	41.5		193	26.0	15 Sept.		
	243	40.5		212	34.5			
	263	37.0		246	40.5			
	270	42.5		261	53.0	Bailey Isl.	[2]253	[2]45.0
	246	38.5		254	35.0	26 Aug.	[2]263	[2]44.0
	217	35.0						
	265	45.0	Prince	257	53.0	14-15 Sept.	[2]265	[2]43.0
	252	42.0	Edward	264	46.0		[2]242	[2]42.0
	262	56.0	Island	271	39.0		[2]255	[2]41.0
	261	41.0	2-4 Oct. 1974	254	47.0		[2]270	[2]41.0
	251	41.0		266	46.0		[2]248	[2]38.0
	218	37.5		266	40.0		[2]243	[2]36.0
	241	38.5		259	40.0		[2]258	[2]36.0
	265	46.5		284	47.0			
				257	37.0			
Gloucester	265	43.0		239	37.0			
2-11 Oct. 1974	258	47.0		267	50.0			

[1]Non-random or selected sample.
[2]Estimated from plotted points of Figure 3.



RESULTS AND DISCUSSION

General

1) The curvilinear relationship discovered about 1950 by Mather and Schuck (Mather, 1959) offers one possible or partial explanation of the relatively long fins being seen in 1974—as the 1974 giants are of larger average size than in any year heretofore, and would be expected to possess relatively longer second dorsal (and anal) fins, on the average, than are generally encountered.

2) The early work[5] of Mather and Schuck also shows that the measured scatter of points around the fin-total length regression line is very much greater for large fish than for small (Fig. 7)[6]. This increasing dispersion offers one possible explanation for occasionally very long second dorsals (as well as very short dorsals) being encountered, especially if one is looking at larger fish than usual.

Western Atlantic

Length of Fins

Figure 8 provides a means to examine all available 1974 Western Atlantic data on relative fin length. It can be seen that within the total sample of randomly selected fish there is no evidence of two distinct types of fish (in regard to relative length of second dorsal fin). There

[5]See Mather and Schuck, 1960 for description.
[6]Unpublished data from Woods Hole Oceanographic Institution (WHOI) files, courtesy of F. J. Mather, III.

Figure 5.—Diagram of measurements taken: (1) Fork length (snout of upper jaw to fork of tail); (4) length of second dorsal fin (measured from end of groove of first dorsal fin to tip of second dorsal lobe).

appears, instead, a gradation from relatively very short to relatively very long second dorsal fins.

To illustrate further, the ratios of all[7] the "randomly" selected 1974 fish are tabulated in Table 6 and plotted in Figure 9. The result is obviously close to a normal curve—a single modal frequency with ratios ranging from 0.120 to 0.220. There is no evidence of a two modal distribution of relative fin lengths.

Next we add the two selected "long fin" fish in both the regression (Fig. 8) and the histogram of ratios (Fig. 9).

It can be seen that the Despres fish (ratio = 0.203) is not substantially longer than many others of the "single mode" random distribution. In fact, some of the normal single-mode randomly selected fish had relatively longer fins than the Despres fish. The conclusion that there were two distinct modal groups (long- and short-finned fish) of the 73 taken during the Bailey Island tournament thus cannot be substantiated with present data.

The SEFC fish from the *A. A. Ferrante* estimated by author from a graphed point to be 238 cm fork length and 61 cm length of second dorsal; for a ratio of 0.256 lies clearly beyond the limits of all previously measured second dorsals. If this fish had been selected randomly, and if others had also been measured, and if this single value represented an average of several, and if these were clustered closely around this point and not spread between it and the smaller fins and if we were sure how this fish was measured, then this observation would certainly be considered as significantly different. But since these conditions do not prevail, the observation does not provide conclusive evidence as to the existence of two types of fish.

The question of whether 1974 fish had relatively larger fins than fish in earlier years was tested by superimposing the regression of 1950 (Fig. 7) onto 1974 data (Fig. 8). It is doubtful that a line of better fit to the 1974 points could be found than the 1950 line.

If ratios are compared, the 1974 Despres fish (ratio of 0.203) is exceeded by

[7] "All" means all fish within the size range of 210 to 279 cm fork length. One fish of 193 cm was excluded due to this necessary constraint if ratios were to be utilized.

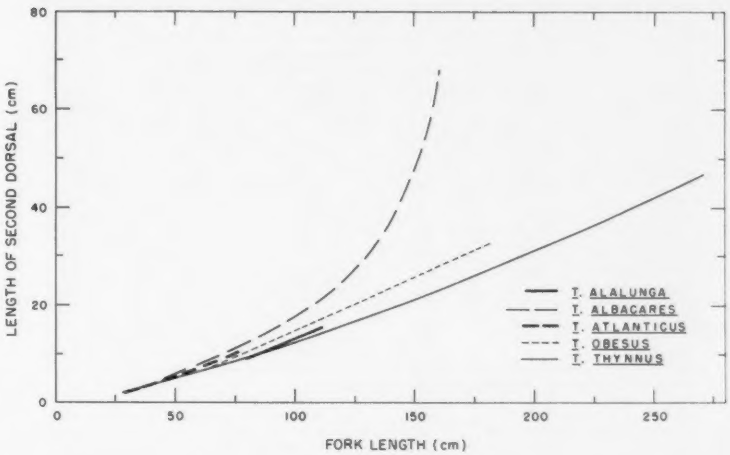


Figure 6.—Length of second dorsal fin plotted against fork length for species of *Thunnus*.

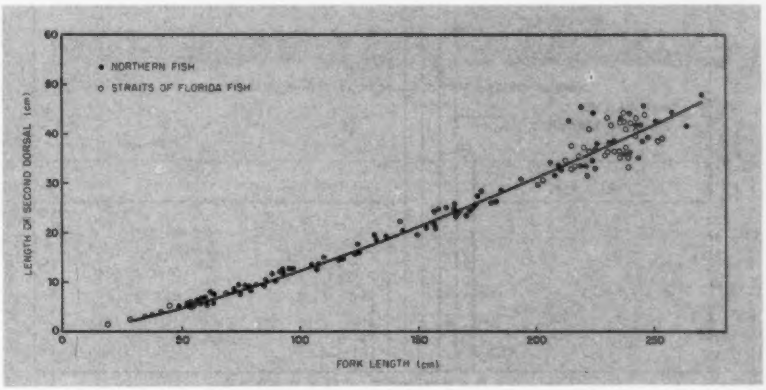


Figure 7.—Relationship of second dorsal to fork length, 1950 era fish.

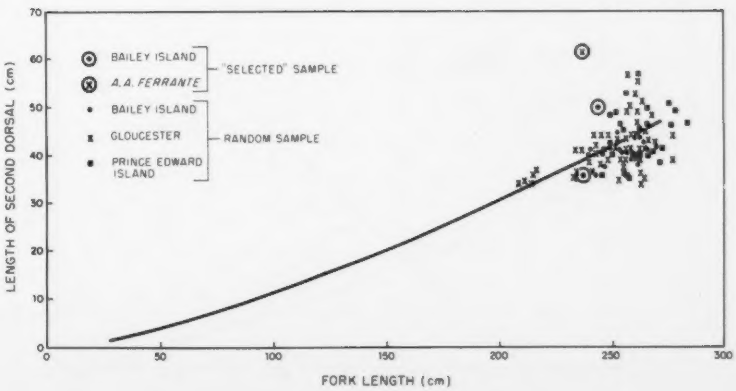


Figure 8.—All 1974 western Atlantic data on fin length.

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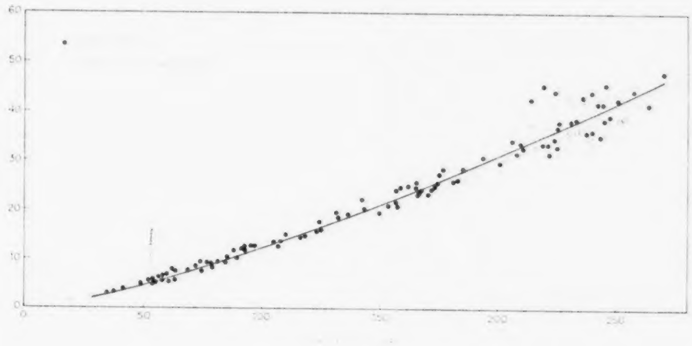

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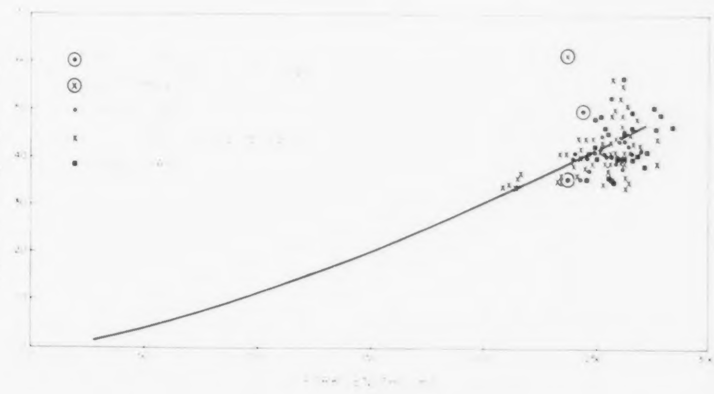

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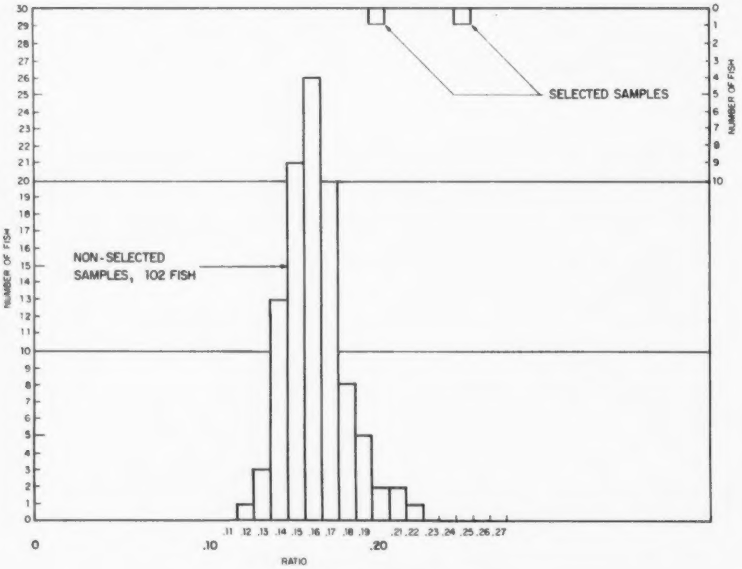
Table 6.—Ratios of 2nd dorsal to total length-1974-Western Atlantic-all[1] random samples of 210 to 279 cm fish.

Ratios range	Mid-point	Number of fish: Bailey Isl., Maine	Gloucester, Mass.	Prince Edward Isl., Canada	All samples
0.120-0.129	0.125	—	1	—	1
0.130-0.139	0.135	—	3	—	3
0.140-0.149	0.145	1	8	4	13
0.150-0.159	0.155	3	12	6	21
0.160-0.169	0.165	3	17	6	26
0.170-0.179	0.175	2	10	8	20
0.180-0.189	0.185	—	4	4	8
0.190-0.199	0.195	—	4	1	5
0.200-0.209	0.205	—	1	1	2
0.210-0.219	0.215	—	1	1	2
0.220-0.229	0.225	—	1	—	1
0.230-0.239	0.235	—	—	—	—
All ratios		9	62	31	102

[1]One Gloucester fish was not plotted as it was less than 210 cm.



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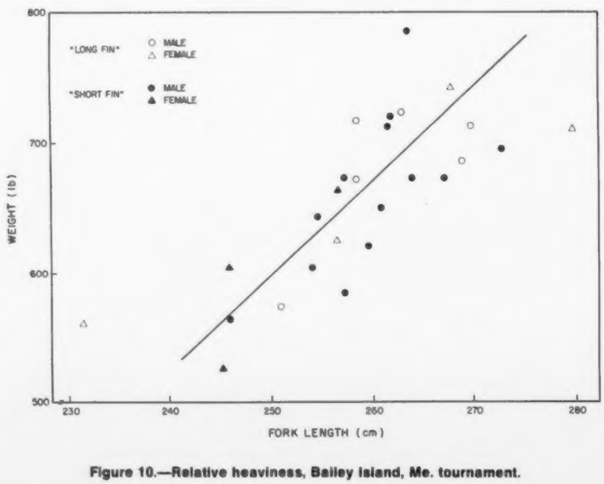

Figure 10.—Relative heaviness, Bailey Island, Me. tournament.

one fish of the 1950 era (ratio of 0.207). (There were also ratios of 0.200 and 0.198 in 1950.)

What is apparent is a greater spread in the 1974 data than in 1950. Thus, in 1974, while there were some fish with relatively long fins, there were also some with relatively shorter fins than in 1950. Why should there be greater biological variation now than then? One explanation would be that it could be merely greater error in measurements. The data in 1950 were collected by experienced personnel using rigorously standardized methods and definitions of end points, with resultant small "manipulative" error in the measurement process. The 1974 data were collected by a number of people, some relatively inexperienced and untrained in measuring tunas, using a variety of tapes and calipers, and measuring sometimes curved distances, sometimes straight line. This fact would increase the errors of measurement, and thus produce a greater "artificial" scatter of points than actually exists in nature.

Relative Heaviness

Although no Western Atlantic observer has mentioned that the "unusual" fish were relatively fat, it is worth a moment to check this possible difference, inasmuch as Sara definitely believed his "long fins" to also be fatter than normal. The data collected by Despres form the basis for one possible test, as she obtained lengths and weights on 26 of the fish classified as either "long" or "short" fin. The average fork length was 101 inches for both groups, and the average weight was 664 pounds for long fin and 640 for short. Inspection of the scatter of these 26 points (Fig. 10) gives no indication that this slight difference in the mean weight is significant.

Turning now to speculation that the "long-finned" may be predominantly of one sex, or are predominantly caught by harpoon (vs bait), we see that: 1) Of 40 fish observed at the Bailey Island tournament, Despres classified 17 (42 percent) as "long fin," 23 as "regular." 2) Of the 17 "long fin," sex determinations were made on 10. Of these 10 "long fin," 6 were males (60 percent), 4 were females (40 percent). However, most (81 percent) of the "regular fin" fish were also males. 3) Of the 17 "long fin,"

13 (76 percent) were taken by harpoon, and only 4 (24 percent) with bait. However, 65 percent of the "regular fin" fish were also taken by harpoon. 4) None of these differences are statistically significant. Thus these speculations are not supported by the available data.

European Waters

Length of Fins

Sara's five fins ranged from 53 to 55 cm, for fish of 250 to 260 cm total length. There is no way to compare these five apparently "selected" second dorsals with the rest of the population (for instance with the rest of the 2,000 fish taken in the area in 1974), as no other measurements were apparently taken—merely these five "unusual" fish.

A poorer basis of comparison could be with the 1974 Western Atlantic fish by superimposing these five points on Figure 8 and provided as Figure 11. The lengths, although longer than average, do not form a five fish group beyond the normal range of dispersion.

Sara's measurements could also be compared to European fish of earlier years. By courtesy of Frank Mather, such a regression[8] of second dorsal to total length is available. Superimposing the five points on this regression (Fig. 12) shows that the early data do not include fish of these large sizes. However a reasonable amount of extrapolation of the data upward to larger-sized fish—and with increasing dispersion (as was found in Western Atlantic fish)—could reasonably place the five fish in the upper limits of a normal dispersion.

The five fish could also be compared to earlier Western Atlantic fish (of our Figure 7). "Superimposing" the five points and providing the result as Figure 13 indicates that the five points are above the dispersion. However, it must be noted that the early data did not include many fish above 250 cm. Also, the ratio of the five fish averages 0.211, and the earlier data do include fish with almost as relatively long a second dorsal fin (ratio of 0.210).

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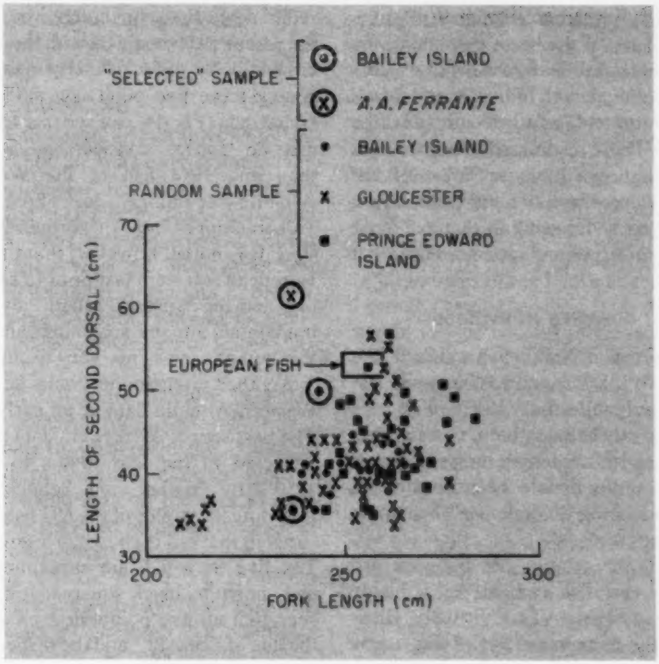


Figure 11.—European fins compared to 1974 western Atlantic.

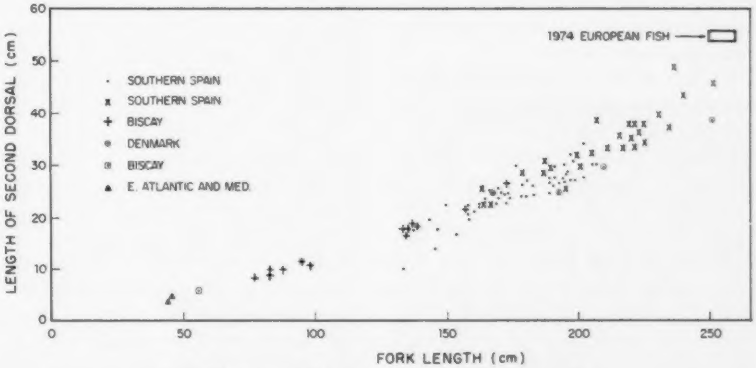
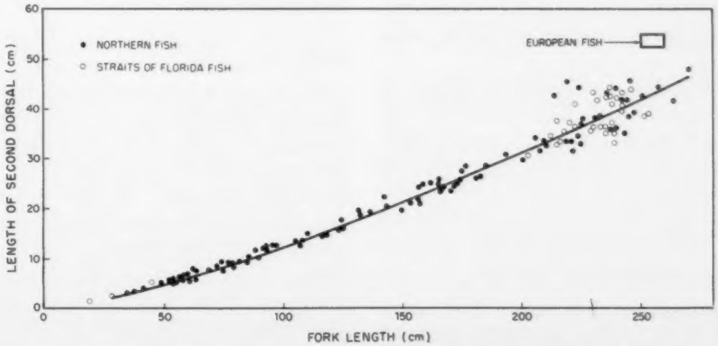


Figure 12.—European fins compared to early era European fish.



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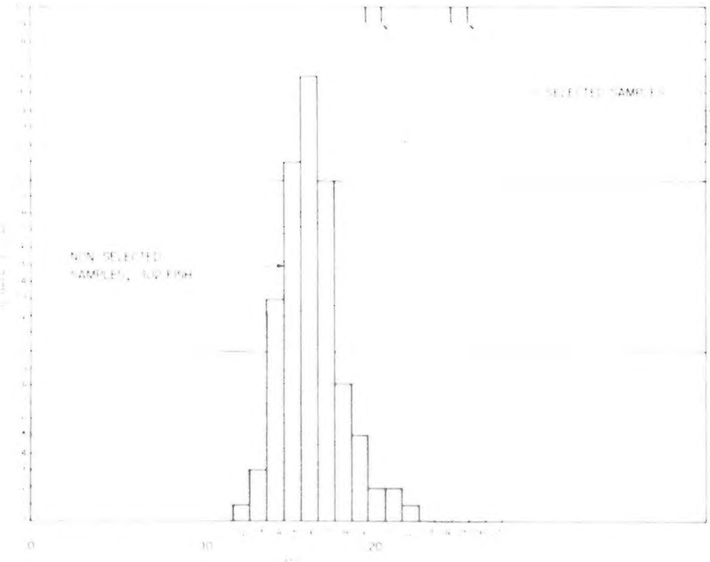

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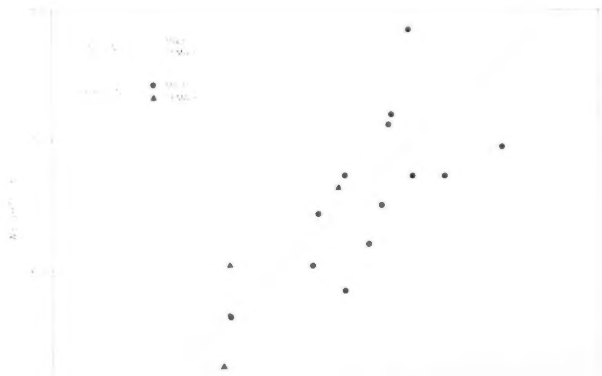

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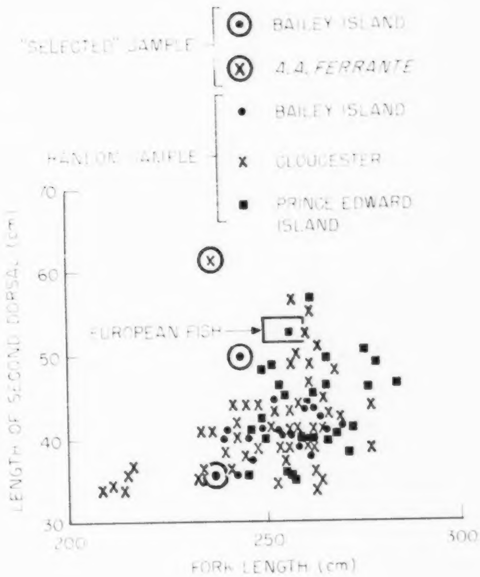

Figure 11.—European fins compared to 1974 western Atlantic.

Figure 12.—European fins compared to early era European fish.

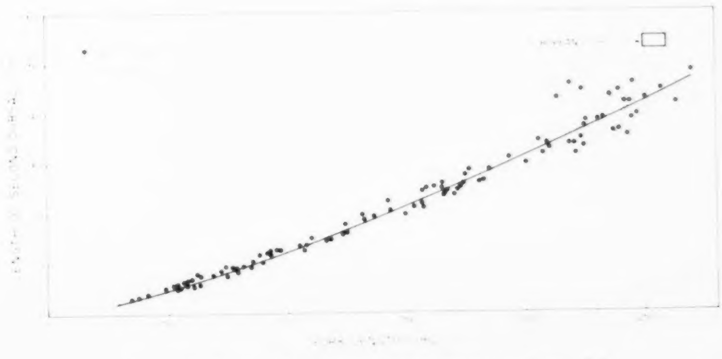

Figure 13.—European fins compared to early era western Atlantic fish.

photointerpretative techniques to establish lengths of the second dorsal of the fish. It is possible, however, to roughly estimate the length of the second dorsal in relation to the fork length (i.e., the ratio). These estimated ratios for the two fish shown in Figure 5 are 0.210 and 0.205. Thus these two fish did not possess clearly longer fins than, at least some, observed and measured in earlier times.

Relative Heaviness

As recalled, Sara's fish weighed 796, 893, 1,014, 1,053, and 1,067 pounds. He is convinced that these fish are significantly heavier than "normal" fish of 250 to 260 cm length range. This is a good juncture to note the constraints on the comparing of "relative" heaviness of bluefin tuna.

First, the relationship between fish length and fish weight is a highly curvilinear[9] one. This virtually eliminates the convenient use of the simple ratio between length and weight as the parameter to be compared. It also forces transformations of at least log-log in order to allow the data to be statistically compared by linear regression methods.

Second, and more important, there has also been demonstrated (see Footnote 9) a highly significant difference in the relative heaviness between seasons of the year. This difference can be over 100 pounds for fish of exactly the same length. Thus valid comparisons of raw data can only be made between fish taken in the same season of the tuna year. In addition, the conditions which apparently cause the large differences (spawning, then a long migration to the feeding grounds, fattening up prior to winter, and then wintering preparation to spawning) do not occur on both sides of the Atlantic in the same months of the year.

With all these constraints, there is unfortunately very little solid data with which the five Sara fish can be compared. First, there is no way to test the hypothesis that these fish are heavier than the other Mediterranean fish taken in 1974, as seemingly no other 1974 fish were weighed or measured.

[9]Unpublished manuscript of early work of Mather and Schuck utilizing measurements of 693 fish. Length-Weight Relationship of Atlantic Bluefin Tuna-Early Era 1948-1952., by H. A. Schuck, in press.

The only basis for comparison with the rest of 1974 would be with the Western Atlantic 1974 fish. By superimposing these five points on all Bailey Island data (Fig. 14), we see that the five fish do appear considerably heavier than any 1974 fish of the Western Atlantic—seemingly far above the probable upper limit of normal dispersion. It is noted, however, that the five European fish were just prior to spawning, and the Western Atlantic data do not contain any pre-spawning fish; thus this comparison is not very useful.

Another comparison could be with Western Atlantic data of an early era. The best source of early era data is that collected in the late 1940's to early 1950's by Mather and Schuck (see Footnote 9). A plot of the 693 fish measured in that era is shown as Figure 15. The five Sara fish are superimposed, and shown as black squares. It can be seen that all five points lie well above the line of "best fit" and the dispersion. However, the 1950 data do not include immediately pre-spawning fish (the first month sampled was May, when most giants have already spawned) and the Sara fish were immediately prespawners. Also the 1950 data did not contain many fish as large as the five Sara fish. At least two of the five are well within the range of what fish of these lengths probably would have weighed if larger-sized fish had been measured in 1950. Even the three other points can be visualized, without too much strain, as part of a "normal" distribution of weights for fish of these very large sizes—especially when we recognize that the Western Atlantic early era data do not include immediately prespawning fish.

Miscellaneous

As to occasional "long-finned" bluefin tuna being strictly a recent phenomenon, it has already been shown that the 1950 collection by Mather and Schuck contained some fish with long fins—even longer than some of the reportedly "very long" 1974 fish. In addition, Frank Mather has brought to our attention another report as early as 1949. "Game Fish of the World," edited by Brian Vesey-Fitzgerald and Francesca Lamonte, under the chapter on Nova Scotia, contains this statement: "It can be generally accepted that

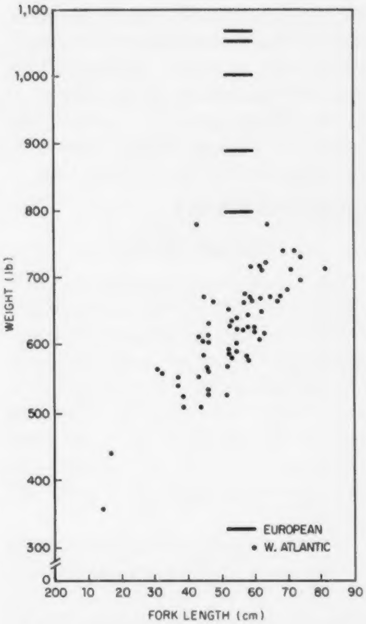

Figure 14.—Relative heaviness of European fish compared to 1974 western Atlantic fish.

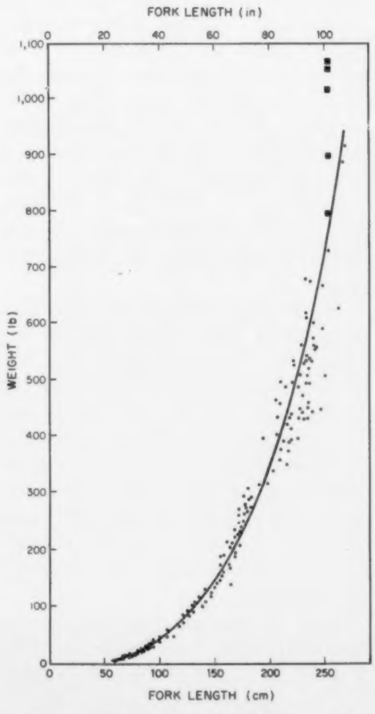

Figure 15.—Relative heaviness of European fish compared to early era western Atlantic fish.

the whole south and east coast of Nova Scotia is potential tuna ground. Long fin are occasionally taken, but bluefin are the usual run." Unfortunately, Francesca Lamonte, now retired, cannot recall the author of this particular bit of information, thus we can do no more than speculate whether this refers to a relatively "long-finned" bluefin tuna, or to another species of tuna—e.g. albacore or bigeye. However, the known range of these species makes the latter extremely improbable. Also small-sized tuna (a characteristic of these species) are rare in Nova Scotia waters. It appears probable therefore, that what is referred to is a relatively long-finned Atlantic bluefin tuna—of the type noticed in 1974.

Another bit of evidence that "unusual" fish (in terms of fatness in this case) have occasionally been taken in early years is found in Farrington (1974), page 18:

> "Mr. Holden then got busy. Around eight in the morning he promptly hooked a fish that weighed 871 pounds. It was only 106 inches long but had an amazing girth of 83 inches—by all odds the most unusual tuna that old-timers at Wedgeport had ever seen. Small wonder Holden caught the fish in fifty minutes; it was so fat it looked like a pompano."

Unfortunately, we have been unable to determine what length measurement was used. Neither Kip Farrington nor the International Game Fish Association (IGFA) official scorer at Wedgeport (Israel Pothier) could recall. It is probable that the "106 inches" is a curved rather than straight distance. But whether it is fork length, or the Wedgeport occasionally-used maximum length (to the end of the caudal lobes), cannot be ascertained.

The very heavy (in terms of length) Canary Island fish was undoubtedly a bluefin tuna of the type measured by Sara, and not a bigeye tuna as identified by its captors. The weight of 1,094 pounds seemingly prevents it from being considered a bigeye. Frade (1931) believed that bigeyes probably reached sizes no greater than 188 cm; Mather (1962) lists their probable sizes as "up to 400 lbs"; Hammond and Cupka (1974) list the present rod and reel record for the species maintained by the IGFA to be 321¾ pounds; and the International Commission for Conservation of Atlantic Tunas lists its maximum size at 190 cm (Miyake and Hayasi, 1972).

CONCLUSIONS

1) It is a fact, known since 1950, that larger bluefin tuna possess relatively longer dorsal fins than do smaller fish—i.e., longer in relation to total length. Thus, as we examine unusually large specimens, we must expect the second dorsal to appear out of proportion to the rest of the body (as judged by the familiar appearance of lesser-sized tuna).

2) The Western Atlantic 1974 data made available for this analysis are not adequate to substantiate the hypothesis that there were two different types of giant bluefin tuna off the U.S.-Canada coast in 1974 and recognizable by relative fin lengths or any other characteristic. In fact, the reported phenomenon (as represented by the data presently available for analysis) can readily be explained by a combination of: (a) chance variation within a single-mode population; (b) actual selection of the longest-finned fish as the samples to be measured; (c) manipulative (measuring) errors, especially in measuring total fish length; and (d) the fact that larger-sized bluefin tuna are known to possess "disproportionately long" second dorsal fins (and also anals).

3) The Western Atlantic 1974 data do not allow for the conclusion that 1974 fish were significantly different from 1950 era fish (for the same reasons as above).

4) The five European fins are long. But considering that the five fish were selected samples, they probably fall within, rather than beyond, the normal expected dispersion for fish of these large sizes for either (a) the 1974 Western Atlantic fish, (b) the older-era European fish, and (c) the older-era Western Atlantic fish.

5) The five European weights are far above the weights of any tuna of these lengths, either in European waters or in the Western Atlantic. However, they are the weights of immediately prespawning fish. There is not immediately available data on weights of other prespawning tuna of large enough sizes to compare with these five, either in Europe or Western Atlantic data sources.

6) In summary, the presently available data representing 1974 fish on either side of the Atlantic do not support the contention that two separate, recognizable groups of *Thunnus thynnus thynnus* were present in 1974; or that the so-called "unusual" group differs significantly in certain body proportions from fish measured in earlier years.

7) It is still possible that, if and when large samples of randomly selected fish become available for analysis, the hypothesis of two distinct "types" of fish can be substantiated. But for now, the theory is unproven.

8) Until two discernible types are demonstrated beyond a reasonable doubt, there seems little to be gained in speculating as to what could be the cause of such a possible phenomenon—i.e. a hybrid with another species (e.g., bigeye tuna, *Thunnus obesus*), a mutant, a subpopulation not normally present in the areas sampled, an age effect (appearing in only very old fish), or a growth form in response to perhaps rapidly decreased population density of the species (which is occurring) and a resultant effect of decreased competition for food or space. Sexual dimorphism would appear eliminated as a possible explanation.

ACKNOWLEDGMENTS

Considerable credit is due to Frank J. Mather, III of the Woods Hole Oceanographic Institution, who has generously provided much background data and also publications that contain material relevant to this study. It was also Mather's translation of a letter for R. Sara of Italy that first divulged, on this side of the Atlantic, the interesting possibility that these seemingly abnormal fish exist.

Sara is to be acknowledged as the first one to have recorded the impression that there seems to be two different types, and the first to have knowingly measured seemingly abnormal bluefin tuna.

Despres of NEFC deserves much credit for her initiative in measuring and recording the weights of almost all fish landed during the Bailey Island Tuna Tournament in July 1974.

Thanks are also due to Francesca Lamonte, formerly of the American Museum of Natural History, to S. Kip Farrington, George Moses, and Israel

Pothier, IGFA measurer at Wedgeport, Nova Scotia, for helping to document the occurrence of "unusual" bluefin tuna during earlier years.

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APPENDIX

The following personal communication is a letter from Raimondo Sara, Sezione di Ricerca per le Conserve, e per i Derivati Agrumari, ESPI, Via Ricaseli, 45, Palermo, Sicily, to Frank Mather, WHOI, Woods Hole, Mass. Translation from Italian is by Frank Mather.

June 10, 1974

Dear Frank:

Excuse me for the delay with which I respond to your last. I have been engaged in work and have been to Favignana at last.

The fishing, at the 7th of June, and that is almost at the end of the campaign, has been:

-Favignana	1,520 tuna
-Formica	510 "
-S. Cusumano (Bonagia)	210 "
-Sardinia	Nothing (?)

Aside from a little group of about 60 tuna of 20/30 kg, the mean weight has been exceptional reaching peaks of 400 kg (!) with enormous fish, some of which were strange, about which I will tell you later.

Now I pose (?) you a problem which has kept me occupied for some weeks. At Favignana I have found some tuna (of 370-485 kg) which I find strange through:

—relatively long pectorals;

—2nd dorsal elongate terminating in a rounded filament, colored clearly in a yellow-orange, with 9 rays; terminates at the level of the IV dorsal finlet;

—anal similarly elongate and colored which terminates at the level of the V anal finlet;

—finlets 9/10 colored in intense yellow and bordered with black;

—liver almost all striated.

Fish of 250/260 cm should have had (according to my old measurements) pectoral fins around 40 cm of length; I find instead 48/50 cm and that is about 5 times (in ?) the length to the fork. The dorsal and the anal are respectively 53 and 52 cm. Furthermore the weight is disproportionate in respect to the length, and therefore, the specimen is fat.

I am sending you a drawing in proportion, while waiting to send you some photographs, if they come out.

I unfortunately was not prepared for such an encounter and therefore had to content myself with hurried measures and without appropriate means, without method of working.

What is happening in the Atlantic and therefore in the Mediterranean? On the one hand I think of the yellowfin, and on the other of the bigeye. But with such large sizes? And the isotherms of (their) distribution? Or is it a question of modifications of the bluefin, in relation to their size (and of their age) and of the areas from which they came, which had not been observed only because:

—fish of such great size and weight were not taken and were not so numerous;

—some populations (where do they come from?) substitute themselves for others?

I would be grateful to you for your opinion. I salute you cordially.

Dearly yours,

/s/

Raimondo Sara

MFR Paper 1168. From Marine Fisheries Review, *Vol. 37, No. 12, December 1975. Copies of this paper, in limited numbers, are available from D825, Technical Information Division, Environmental Science Information Center, NOAA, Washington, DC 20235. Copies of* Marine Fisheries Review *are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402 for $1.10 each.*

MFR PAPER 1169

Exploratory Shrimp Trawling in the Hawaiian Islands

PAUL STRUHSAKER and HOWARD O. YOSHIDA

ABSTRACT—The results of exploratory shrimp trawling in the Hawaiian Islands during six cruises of the RV Townsend Cromwell *are given. One species of shrimp,* Penaeus marginatus, *was f. und in quantities thought sufficient to sustain a small trawl fishery. Average catches in the four most productive areas ranged from 4.7 to 31.0 pounds (2.1 to 14.1 kg) per hour (heads-on weight) with a single 41-foot (12.5-m) shrimp trawl. Evidence is presented that individual shrimp move offshore into depths of 100-125 fathoms (185-230 m) during daytime, with most individuals returning to shallower depths of 35-100 fathoms (65-185 m) during night. Optimum trawling speed was between 2.3 and 3.0 knots with best catches being made at 2.5-2.8 knots. The size of the shrimp at most stations ranged from 16 to 19 individuals per pound (heads-on). In any given depth range the females tend to be larger than males. In depths greater than 100 fathoms (185 m) the males are 3-4 times more numerous than females. Small amounts of shrimps of the genera* Heterocarpus, Aristeus, Pandalus, *and* Pleisioneka *were taken in depths of 150-385 fathoms (275-705 m), but never in quantities sufficient to justify the sorting effort required. Catches of white crabs ranged up to 30 pounds (13.6 kg) per tow, while incidental catches of slipper lobsters, spiny lobsters, and kona crabs were also made.*

Figure 1.—A portion of a catch of *Penaeus marginatus* trawled in the Hawaiian Islands.

During the 1902 expedition of the U.S. Fish Commission's steamer *Albatross* to the Hawaiian Islands, large specimens of the penaeid shrimp, *Penaeus marginatus* Randall (Fig. 1), were taken with beam trawls in Pailolo Channel at depths of 122-141 fathoms (220-255 m) (Rathbun, 1906). Because contemporary charts indicated that Pailolo Channel and other areas of the Hawaiian Islands offered moderate amounts of grounds that might be trawlable in depths presumably inhabited by adult *P. marginatus*, the National Marine Fisheries Service (NMFS), in cooperation with the Hawaii Institute of Marine Biology, conducted four exploratory trawling cruises with the RV *Townsend Cromwell* during 1967 and 1968 to assess the demersal shrimp and fish resources of the main group of the Hawaiian Islands (Fig. 2). Yoshida (1972) reported on the shrimp catches for the first three cruises, while Struhsaker (1973) discussed the ichthyological results. The results of these four cruises and subsequent trawl surveys during 1971-72 are summarized here. We conclude from these investigations that *P. marginatus* occurs in sufficient quantities to support a small commercial trawl fishery.

GEAR AND METHODS

Most of the trawling effort during the first four cruises was conducted with 41-foot (12.5-m) headrope 4-seam flat shrimp trawls such as described by Bullis (1951) and Schaefers and Johnson (1957). Similarly constructed trawls with headrope lengths of 27 feet (8.3 m) and 71 feet (21.5 m) were also utilized during the first cruise, as was a 71-foot headrope fish trawl (Greenwood, 1958).

Trawling surveys conducted during 1971-72 utilized, almost exclusively, 41-foot headrope 4-seam flat and semiballoon shrimp trawls similar to those described by Greenwood (1959), with mud rollers mounted about every three feet (1 m) on the foot rope. A 60-foot (18.3-m) headrope semiballoon

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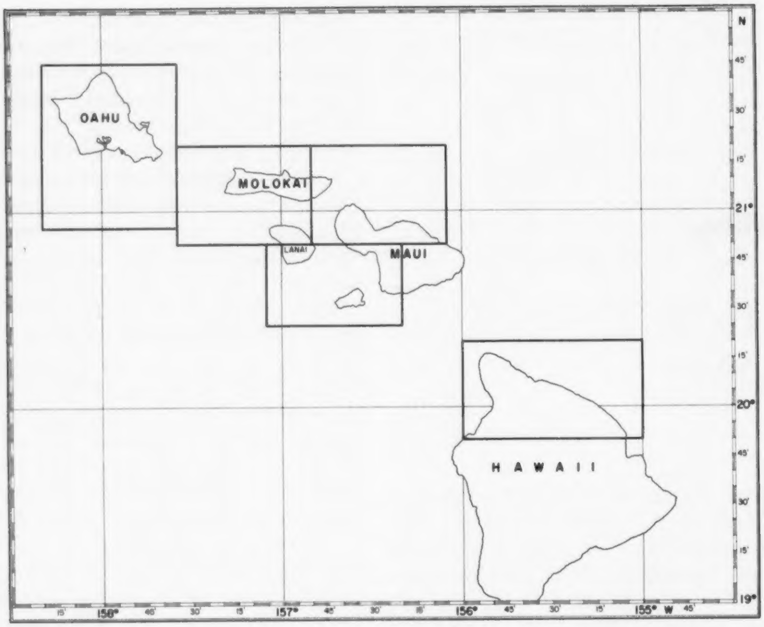

Figure 2.—General areas where trawl surveys were conducted in the main group of the Hawaiian Islands.

shrimp trawl with no mud rollers was briefly tested during fall 1972.

The shrimp trawls were all constructed of 1.5-inch (38-mm) stretched mesh nylon webbing throughout the body and cod end. The foot ropes were weighted with 0.25-inch (6-mm) loop-chain attached at 1-foot (0.3-m) intervals. Tickler chains of 0.25-inch stock were used on all shrimp trawls.

The 41-foot trawls were fished on a single wire with a 15-fathom (27-m) bridle. Although conventional Gulf of Mexico type wooden doors (Bullis, 1951) were tried initially, modified aluminum V-doors as described by Barraclough and Johnson (1960) were used at most of the stations. The aluminum doors were superior to the wooden doors, especially in the deeper sets. The 60-foot trawl was fished with two warps and spread with 7-foot (2.1-m) steel Chinese V-doors.

During the first four cruises, 225 shrimp trawl stations were conducted in the 35-385 fathom (66-705 m) depth range. At 161 stations the 41-foot flat trawl was used and fished correctly with little or no damage. Additional shrimp trawling stations were effected during spring 1971 (23 stations) and fall 1972 (29 stations). Single trawls were fished at all stations and towing times ranged from about 0.5 to 4.0 hours, with most hauls ranging from 1 to 2 hours in duration.

One advantage of deep-water trawling in areas similar to the Hawaiian Islands is that the nearness of the land masses provides fixed geographic reference points for accurate positioning of vessels not equipped with precision navigational systems. Position data are probably accurate to less than 0.1 mile. We considered that a tow began at "dog-off" and ended at the beginning of "haul-back." Although the actual times that the trawl began and ended fishing were not accurately known, it was assumed that the time lags at the start of both operations approximately canceled one another. This assumption is probably valid for shallow waters, but greater variance must be assumed with increased fishing depths. Stations where the gear fished satisfactorily and suffered no damage, or damage so slight that it was considered that the sampling efficiency of the trawl was not affected, were considered to be "quantitative." These stations were used in the calculation of catch rates of shrimp to determine the effects of trawling speed, depth of water, and time of day. For the determination of catch rates per unit area, it was assumed that the 41-foot trawls had an effective sampling width of 23 feet (7 m).

During the first cruise, emphasis was placed on becoming familiar with bottom trawling techniques and gaining an introductory knowledge of the bottom resources in depths greater than 100 fathoms (185 m). Two subsequent cruises during spring 1968 emphasized the exploration of additional areas that might have harvestable populations of *P. marginatus*. During the fourth cruise (fall 1968), four areas where *P. marginatus* was found to be most abundant during the previous cruises were extensively surveyed to determine the availability of the species in relation to the factors of depth and time of day.

Although some gear damage was experienced during all cruises, once the characteristics of the various areas were learned tear-ups were greatly reduced. During the last cruise when 119 trawling stations were effected, only four tows were unsuccessful: one was a water-haul; very light trawl damage was experienced at two stations; and heavy damage was experienced at one station. The last station was an attempt to sample a broken-bottom area in shallow water.

RESULTS

Trawling Areas and Shrimp Catches

The four areas where the best catches of *P. marginatus* were made are discussed first. The catch rates for these areas are summarized in Table 1. Most of the data are for fall 1968 when the greatest number of quantitative stations were made. The results of fishing during spring 1971 and fall 1972 in the Pailolo-Molokai area are also given. All catch weights (heads-on) are for single 41-foot shrimp trawls except for the 1972 samples when a 60-foot shrimp trawl was used. Areas where only small catches of *P. marginatus* were made, or where other species of shrimp were found are also discussed.

Northwest Molokai

Although the northeastern coast of the island of Molokai presents one of the world's most dramatic sea scarps, which continues in places to great depths, the undersea portion of the

Table 1.—Catches of *Penaeus marginatus* with a 41-foot shrimp trawl in four areas of the Hawaiian Islands (heads-on weights).

Area and time	Year	No. of stations	Range of catch per station lb	Range of catch per station kg	Range of catch per hour lb	Range of catch per hour kg	Average catch per station lb	Average catch per station kg	Average catch per hour lb	Average catch per hour kg
Northwest Molokai	1968									
Night		9	5-16	2.3- 7.3	2.3- 7.6	1.0- 3.5	10.9	5.0	4.7	2.1
Penguin Bank	1968									
Night		16	11-33	5.0-15.0	5.5-19.4	2.5- 8.8	20.4	9.3	10.8	4.9
Pailolo Channel-Maui	1968									
Night		10	4-35	1.8-15.9	2.4-17.5	1.1- 8.0	15.3	7.0	7.6	3.5
Day		6	2-29	0.9-13.2	1.1-13.2	0.5- 6.0	18.8	8.5	9.5	4.3
Pailolo Channel-Molokai	1968									
Night		7	6-53	2.7-24.1	2.9-23.0	1.3-10.5	23.4	10.6	11.3	5.1
Day		7	33-105	15.0-47.7	17.4-47.7	7.9-21.7	59.1	26.9	31.0	14.1
	1971									
Night		4	23-58	10.5-26.4	11.6-27.2	5.3-12.4	34.8	15.8	18.1	8.2
Day		6	42-75	19.1-34.1	20.8-37.5	9.5-17.0	59.7	27.1	29.8	13.5
Day	1972	10	40-75	18.2-34.1	20.0-37.5	9.1-17.0	55.1	25.0	27.5	12.5

northwest coast is a continuation of the low, gently sloping west Molokai Dome until the shelf break is encountered at about 95 fathoms (175 m). West of long. 157°05′W, trawlable bottom extends for about 10 nautical miles (18 km) in depths of 55-95 fathoms (100-175 m) (Fig. 3). The bottom type is muddy sand with moderate amounts of sponge. Although the surveys were restricted to an area estimated to be 5.5 square nautical miles (18.7 km²), quite possibly this ground could be extended to a greater depth and farther westward.

Of the four most productive areas, northwest Molokai was the shallowest and produced the smallest catches. During fall 1968 the depths sampled ranged from about 65 to 70 fathoms (120 to 130 m). *P. marginatus* was only taken during night tows with catches ranging from 5 to 16 pounds (2.3 to 7.3 kg) per station (Table 1).

Penguin Bank

An 8-mile (14.8-km) long trawlable area of about 3.0 square miles (10.3 km²), centered on the 100-fathom (185 m) depth curve between long. 157°22′W and 157°30′W, was located on the north edge of Penguin Bank west of Molokai (Fig. 3). The bottom type is coralline sand and rubble with moderate amounts of sponge and algae. A few subsequent stations during 1971 demonstrated that the depth limits and east-west boundaries of the area sampled may be extended somewhat.

This area was the second shallowest, with most tows being made in the 100-fathom (185-m) depth range. Again, almost all catches of *P. marginatus* were made at night, although frequently a few shrimps were taken during day stations (<1 pound per station). The night catches ranged from 11 to 33 pounds (5-15 kg) per tow (Table 1).

Pailolo Channel

Pailolo Channel, between the islands of Maui and Molokai (Fig. 4), may be likened to a dead-end canyon sloping gently to the northeast with a level floor of muddy sand at depths of 120-130 fathoms (220-247 m). Although the entire channel in these depths is generally trawlable, the best shrimp catches were made in depths of 110-120 fathoms (200-220 m) on the southeast edge of the channel near Maui and on the northwestern edge near Molokai. The "Pailolo Channel-Maui" ground extends from about lat. 21°03.2′N, long. 156°41′W to lat. 20°58.2°N, long. 156°46.3′W, a distance of about 7 miles (13 km), with an area of about 3 square miles (10.2 km²). The "Pailolo Channel-Molokai" ground extends from about lat. 21°05.5′N, long. 156°42.5′W to lat. 21°01.5′N, long. 156°50′W, a distance of about 8 miles (14.8 km), with an area of about 4 square miles (13.7 km²).

The better catches of *P. marginatus* were made in the 110-120 fathom (200-220 m) depth range in Pailolo Channel during both day and night hours. Catches on the Maui side of the channel ranged from 4 to 35 pounds (1.8-15.9 kg) during night stations and 2 to 29 pounds (0.9-13.2 kg) during day stations. However, the day stations yielded a higher average catch than the night stations (Table 1).

Stations made during 1968 on the Molokai side of Pailolo Channel produced the best catches of *P. marginatus*. They ranged from 6 to 53 pounds (2.7-24.1 kg) per tow at night and 33 to 105 pounds (15-47.7 kg) per tow during daylight hours (Table 1). During spring 1971, when a 41-foot

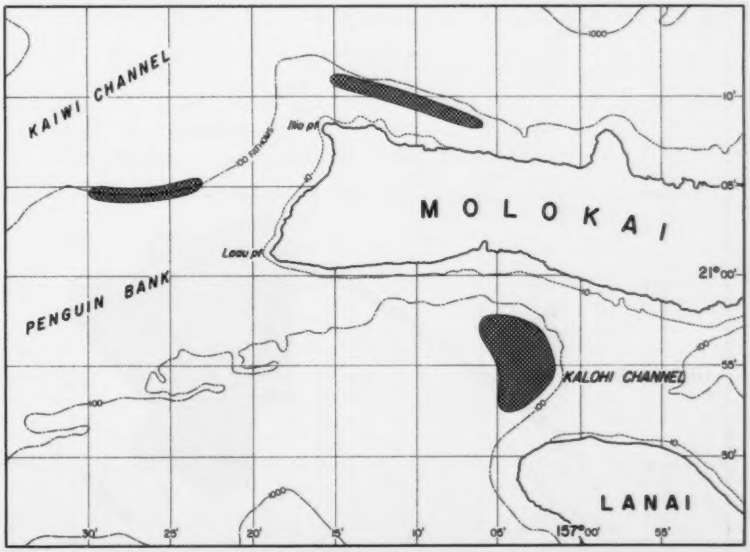

Figure 3.—Trawlable areas (hatched) in the vicinity of west Molokai.

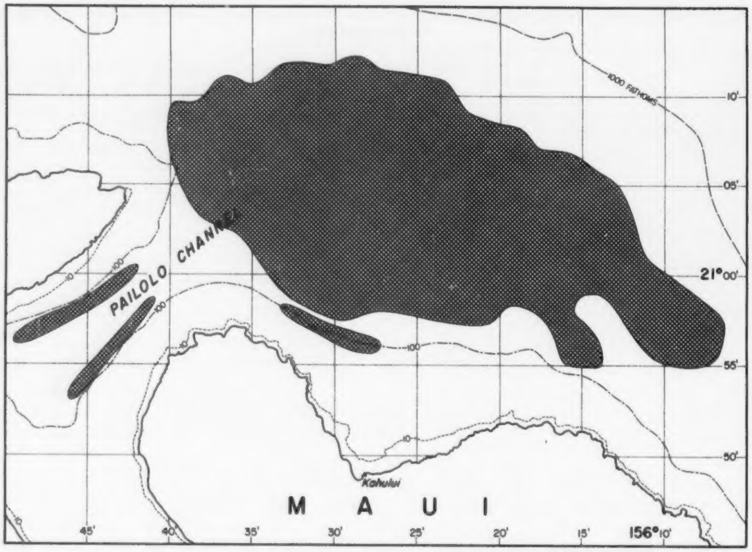

Figure 4.—Trawlable areas in Pailolo Channel and north of Maui.

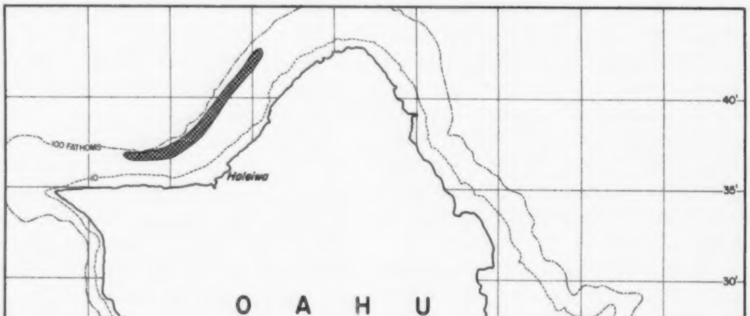

Figure 5.—Trawlable areas near Oahu.

semiballoon trawl with mud rollers was utilized, catches were similar. Night tows at that time produced catches of 23-58 pounds (10.5-26.4 kg), while day tows ranged from 42 to 75 pounds (19.1-34.1 kg). Finally, during fall 1972, 10 daylight stations with a 60-foot shrimp trawl without mud rollers produced catches of 40-75 pounds (18.2-34.1 kg). These stations with the larger trawl produced smaller average catches than the previous sampling with 41-foot trawls, probably because optimum trawling techniques with the gear were not yet fully developed during this series of stations.

Areas where only small catches of *P. marginatus* and other species of shrimp were taken are discussed below.

Haleiwa

Good trawlable bottom was located off the north coast of Oahu in the 55-65 fathom (95-115 m) depth range (Fig. 5) during the cruises conducted in 1968. Smooth sandy bottom extends from due north of Haleiwa northeast to the latitude of Kahuku Point and no trawling difficulties were experienced. A secondary area extends from off Haleiwa westward 5 miles to about long. 158°12′W consisting primarily of smooth sand bottom with some coral and rock outcrops. Trawling was generally successful, but occasional gear damage caused this latter area to be classified as "marginal." Live sponges often made up a large portion of the catches in both subareas.

A few subsequent stations during 1972 demonstrated that trawlable bottom extends out to depths of 120 fathoms (220 m) between Haleiwa and Waimea Bay.

Although substantial sampling was conducted at depths of 55-65 fathoms (95-115 m), catches of *P. marginatus* were made only at night and were considered to be spotty. Catches during fall 1968 ranged from 0.2 to 3.0 pounds (0.1-1.4 kg) per tow. Six night-trawl stations further offshore in depths of 80-120 fathoms (145-220 m) during 1972 produced catches ranging from 3 to 11.5 pounds (1.4-5.2 kg) per hour. Although further delineation of trawlable grounds in the deeper water portions off north Oahu is desirable, it would seem that moderately good catches could be made on a sustained basis.

Maui

An extensive area of trawlable grounds was located off the north coast of Maui (Fig. 4), but most of it lies in depths of 175-350 fathoms (325-650 m), below the depth range inhabited by *P. marginatus*. During the 1967-68 cruises, the bottom off north Maui in depths less than about 150 fathoms (275 m) was classified as only marginally trawlable. Several stations were effected in depths of 35-40 fathoms (65-75 m), resulting in a best catch of 4 pounds (1.8 kg) of *P. marginatus* for a 1-hour tow. Two additional stations made during 1971 indicated that trawlable grounds are present in the 95-120 fathom (175-220 m) depth range. This latter area extends from north of Kahului Harbor west-northwest for about 7 miles (13 km) along the 100-fathom (185 m) curve (Fig. 4). The stations were made during daylight hours and the best catch was 9.2 pounds (4.2 kg) for a 2-hour tow. Further explorations in this area seem warranted.

Kealaikahiki Channel

Good trawlable grounds were located in Kealaikahiki Channel between the islands of Lanai and Kahoolawe (Fig. 6). Approximately half of the area bounded by the 100-fathom (185 m) curve on the north, east, and south, and 250 fathoms (455 m) to the westward consists of smooth mud and sandy mud bottom. Small amounts of *P. marginatus* were taken off southeastern Lanai. All stations were made during the first cruise, and the sampling gear used here was less efficient than that used on later cruises. Best catches were made with a 27-foot shrimp trawl which resulted in 27 shrimps taken in a 60-fathom (108 m) night tow and 28 taken in a 124-fathom (226-m) day drag (both tows of 1-hour duration).

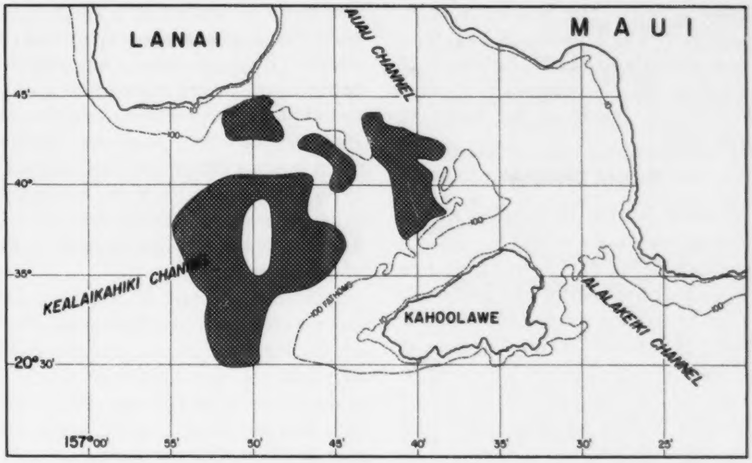

Figure 6.—Trawlable areas between the Islands of Lanai and Kahoolawe.

Hamakua Coast

The Hamakua Coast of northeast Hawaii (Fig. 7), between Waipio Valley and Hilo Bay, offers good trawling grounds in depths inhabited by *P. marginatus*. However, sugarcane plantations along the coast have been dumping cane trash directly into the ocean for many years. Large quantities of trash taken in the trawls (up to 3,000 pounds) so hampered the operations that extensive trawling was not undertaken. Our limited sampling was insufficient to determine what effect, if any, the cane debris has on the bathyal environment and associated animal communities. There is little doubt, however, that this area is an excellent example of a deep-sea environment extensively altered by

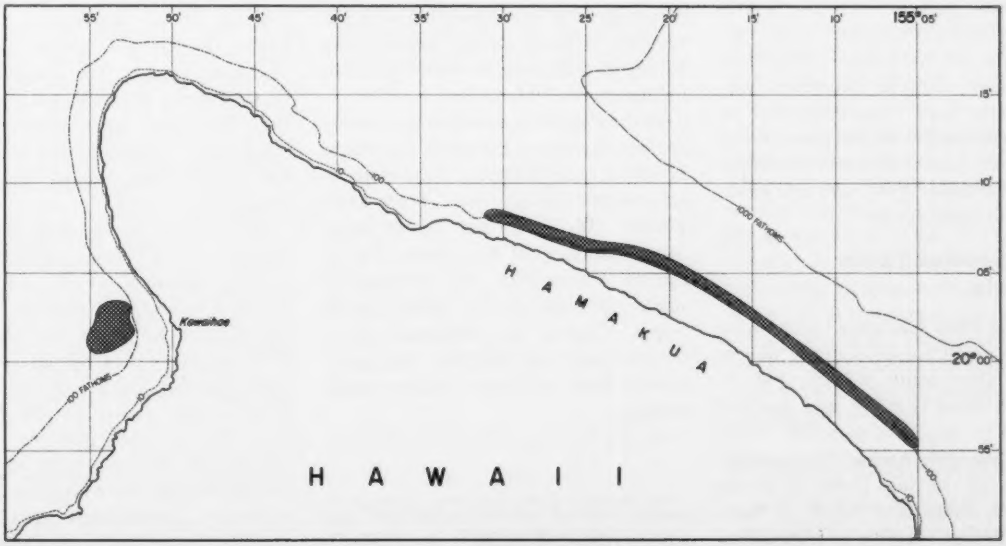

Figure 7.—Trawlable areas off the Island of Hawaii.

human activity. The best catch of *P. marginatus* was 7 pounds (3.2 kg) for a 1-hour daylight tow in 122 fathoms (225 m) during 1972. No catches of *P. marginatus* were made in the following three areas.

Kalohi Channel

A small portion of western Kalohi Channel was found to have a smooth mud bottom (Fig. 3). The trawlable area is bounded on the north, east, and south by the base of the recent shelf break at about 125 fathoms (230 m). The floor of the channel slopes gently westward to about the 165-fathom (330-m) curve where the bottom becomes broken and trawling conditions are marginal.

Kaiwi Channel

The portion of Kaiwi Channel between Honolulu Harbor and Makapuu Point (Fig. 5) was found to be trawlable in depths greater than about 300 fathoms (550 m). One tear-up was experienced when rough bottom was encountered at about 275 fathoms (500 m) on the north edge of Penguin Bank.

Kawaihae

A small trawlable area of smooth, sandy mud bottom in the 130-220 fathom (235-400 m) depth range was located due west of Kawaihae (Fig. 7). The 50-300 fathom (90-550 m) depth range off this coast between lat. 19°50′N and Malae Point (lat. 20°06′N) was extensively surveyed. Bottom conditions, for the most part, are very rough with reliefs of 25-30 fathoms (45-55 m) common in the 190-300 fathom (350-350 m) depth range. Bottom recordings indicated very heavy concentrations of fishes associated with the pinnacles in this region; limited attempts to sample these populations with traps and handlines were unsuccessful.

Other Species Taken In Trawls

Several other species of shrimp were taken in small amounts in the deeper trawling areas south of Oahu (Fig. 5), off north Maui (Fig. 4), and south of Lanai (Fig. 6). They generally occur deeper than 150 fathoms (275 m) and the problem of sorting them from the numerous fishes also taken in these depths renders trawling an impractical means of harvest. The penaeid *Aristeus semidentatus* was taken in small numbers, with catches ranging up to about 2 pounds (1 kg) per hour. Only slightly better catches were made of the caridean shrimps *Heterocarpus ensifer* and *H. laevigatus*, but they are readily taken in traps (Struhsaker and Aasted, 1974). Several small species belonging to the genera *Pandalus* and *Pleisioneka* were also present in small amounts in all of the deeper tows.

Incidental catches of other crustaceans were also made. During fall 1968 white crabs, *Portunus sanguinolentus*, were taken at every station off Haleiwa in depths of 54-66 fathoms (99-121 m) with catches ranging up to about 30 pounds (13.6 kg) and averaging 13.5 pounds (6.1 kg) per tow. This species was also present in every station off northwest Molokai in depths of 65-68 fathoms (120-124 m). Catches were smaller, however, averaging 5.8 pounds (2.6 kg). The size of the crabs ranged from about 3 to 7 individuals per pound (6-15 per kg).

During fall 1968, slipper lobsters, *Scyllarides squamosus*, were present at 6 of 11 stations off northwest Molokai. From 1 to 4 individuals were taken per tow and weighed 1-2 pounds each. At the same time six spiny lobsters, *Panulirus marginatus*,[1] were taken at three stations. Finally, individual kona crabs, *Ranina serrata*, were taken on several occasions at depths of 100 fathoms on the north edge of Penguin Bank. These catches are of interest primarily from the standpoint of depth records for these species: perhaps trap fishing at these depths would prove to be commercially feasible.

In the Pailolo Channel areas, several species of fishes were taken that might be sold in local markets. These incidental catches usually ran about 40-60 pounds (18-27 kg) per 2-hour drag. Small flatfishes of the genera *Taeniopsetta*, *Parabothus*, and *Arnoglossus* made up most of the finfish catch. Papio, *Caranx* sp.; aweoweo, *Priacanthus* spp.; and boarfish, *Antigonia steindachneri* were also taken in small amounts.

On the Molokai side of Pailolo Channel, dead "trees" of black coral, *Antipathes* sp., were often taken in the trawls: catches of 25 pounds (10 kg) were not unusual.

[1]This endemic species was long known as *P. japonicus* but was recently referred to *P. marginatus* (Quoy and Gaimard) by George and Holthuis (1965). Brock (1973) recently reported the species from Johnston Atoll.

Variation In Catch Rates

The reasonably accurate station position data obtained during the surveys permit an examination of the effects of time of day, depth of water, and towing speed on the catch rates of *Penaeus marginatus*. Only quantitative stations with a 41-foot 4-seam flat shrimp trawl (without mud rollers) from the first four cruises are considered. The estimated area sampled by a trawl was converted to hectares and catch rates are expressed as numbers of shrimp per hectare. The time of the station is considered to be the median between on- and off-bottom times.

It soon became apparent during the early cruises that the catches of *P. marginatus* varied markedly by time of day and depth of water fished. While catches were made at night in the shallower areas, shrimp were taken during both day and night in depths of 110-125 fathoms (200-230 m). However, in these deeper areas, daytime catches were higher than those of night catches (Table 1).

The effects of time of day and depth of water are summarized in Figure 8, where average catches are given for five depth zones for 3-hour periods throughout the day. Sampling effort ranged from one to nine stations for each combination of the two factors. Unfortunately, there is no extensive area in the Hawaiian Islands that permits a continuous series of trawling stations over the entire depth range inhabited by *P. marginatus*. Therefore, the data for the five depth zones treated are for five geographical areas.

The deepest depth zone of 110-125 fathoms (200-230 m) is represented by catches obtained at 42 stations in Pailolo Channel. For each time period, the catches for both the Maui and Molokai side of the Channel were averaged together. Although the catches were usually higher on the Molokai side, the day-night patterns in catch rates for the two areas were similar. Although shrimps were taken at all times of the day, catches were highest during daylight hours and considerably reduced during night.

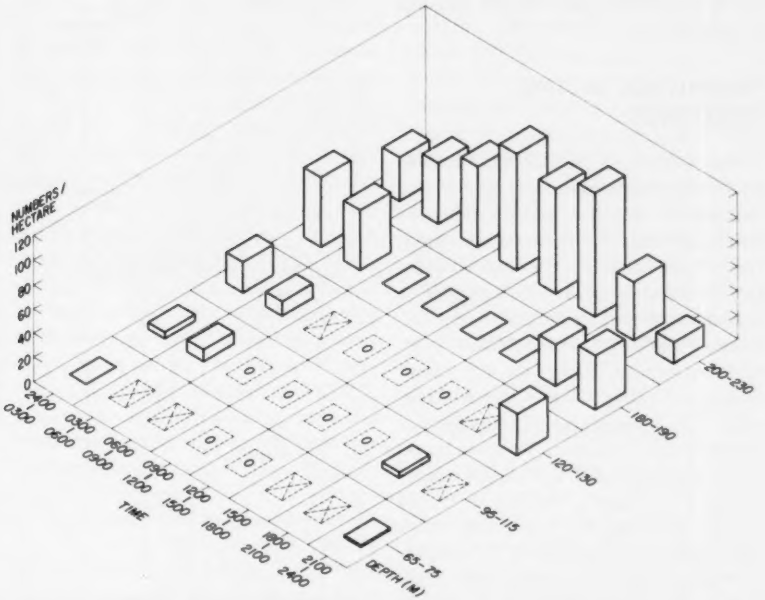

Figure 8.—Average catch rates (numbers per hectare) of *Penaeus marginatus* by time of day and depth. Cells with a dashed rectangle and an "O" indicate that no *P. marginatus* were taken for that combination of factors, while rectangles with an "X" indicate that no sampling was conducted for that combination of factors.

The data for the 99-104 fathom (180-190 m) depth range were obtained from 41 stations in the Penguin Bank area where the best catches were made at night. Only a few shrimps were taken during daytime, and catch rates averaged less than one shrimp per hectare.

The 65-70 fathom (120-130 m) depth range is represented by the northwest Molokai area where 22 stations were made. Shrimps were taken only during 2100-0600 hours. No stations were made during 0600-0900 hours and 1800-2100 hours, and while sampling was conducted during the three time periods between 0900 and 1800 hours, no shrimps were taken.

A total of 23 stations in the Haleiwa area provide the data for the 53-63 fathom (95-115 m) depth range. No daylight catches of shrimps were made and only small catches were made at night. No median sampling times fell within the 2100-2400 hours time period.

Five stations, all off north Maui, were made in the 35-40 fathom (65-75 m) depth range. Only small amounts of shrimps were taken during night in these depths.

We believe that the pattern of catches of *P. marginatus* can best be explained by a nocturnal movement of the shrimp into shallower depths. In the areas considered, the slope of the bottom is such that the shrimps would have to undertake horizontal movements of only about 1 mile (1.9 km) to effect depth changes of 40 fathoms (75 m). This is indicated by the reduced night catches in the deepest depth zone, higher night catches in the next deepest zone, and progressively smaller catches in each succeeding depth zone. As pointed out by Pearcy and Laurs (1966), strong evidence for vertical migration in midwater animals is provided in a case where daytime catches of an animal exceed those of the night catches in the same depth zone. Presumably, the animals can better avoid the trawl during daylight; thus, reduced nighttime catches are indicative of movement out of the depths being sampled.

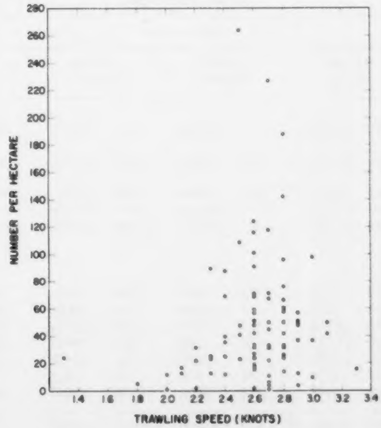

Figure 9.—Number of *Penaeus marginatus* taken as a function of trawling speed.

Thus *P. marginatus*, like most other species of the genus, appears to be negatively phototactic (avoids light). However, it seems as though most individuals of *P. marginatus* accomplish this by moving offshore into deeper water during daytime, rather than burrowing during daylight hours as do most other species of *Penaeus*. However, captive specimens of *P. marginatus* have been observed to burrow readily, and burrowing may also be an important behavioral component of this species. As discussed below, smaller shrimps occur in shallower depths. Possibly the smaller shrimps undertake more limited movements offshore and burrow to some degree. If the smaller shrimps occurring in the shallower depths burrowed during daytime and did not undertake any migratory movements, then we would expect to occasionally capture a few shrimps during daylight stations. However, not one *P. marginatus* was taken between 0600 and 1800 hours in depths of 70 fathoms (130 m) or less.

We also examined the effect of trawling speed on the catch rates of *P. marginatus*. Figure 9 shows the relationship between catch and towing speed for 83 stations. Zero-catch stations were not plotted. The optimum towing speed appears to range from about 2.3 to 3.0 knots, with the best catches being made at 2.5 to 2.8 knots. There is considerable variation in catch rates within the indicated optimum towing speeds. This is due to variation in the abundance of shrimps by depth and time of day as discussed above. We assume that at lower trawling speeds the shrimps avoid the trawl more readily, and at higher speeds the trawl lifts off the bottom, permitting the shrimp to escape under the trawl.

GENERAL OBSERVATIONS

At each station where *P. marginatus* was taken, the shrimp were counted and weighed. At 63 stations where the catch exceeded 5 pounds, the shrimp ranged

from 14 to 23 individuals per pound (heads-on). Shrimp in most of the catches (45 stations) ranged from 16 to 19 per pound, and the average for all stations was 17.7 per pound.

The percentage of the total weight of the shrimp contributed by the tail (shell on) was determined at eight stations; the tails make up 50 percent to 55 percent of the total weight.

The total lengths (tip of rostrum to tip of telson) were determined for many specimens of *P. marginatus*. Length frequencies for three stations are presented here to illustrate the main conclusions resulting from analysis of these data. At all stations during the surveys, female shrimp ranged to a larger size than the males (Fig. 10). The shrimp taken in the shallower portions of the Haleiwa area tended to be smaller than those from Pailolo Channel. Finally, there were no obvious seasonal differences in the size of shrimp inhabiting depths of 100-125 fathoms (185-230 m). This is shown for the Pailolo Channel in Figure 10, where a sample collected during fall (C and D) is compared with one collected during spring (E and F).

Although the numbers of male and female shrimp are about equal in lesser depths, the males consistently outnumber the females by ratios of 3-4 to 1 in depths of 100-125 fathoms (185-230 m). This is illustrated in Figure 10, for which random samples from Haleiwa (A and B) and Pailolo Channel (E and F) are presented. The other Pailolo Channel sample in the figure (C and D) is not a random one.

MAGNITUDE OF THE RESOURCE

An estimate of the standing biomass of *P. marginatus* available at any one moment on the four most productive fishing grounds was made by determining average catch rates per unit area (for fall 1968) and the area of each ground. A summary of these estimates is as follows: Pailolo Channel-Molokai side, 8,316 pounds (3,780 kg) for 4.0 square miles (13.7 km^2); Pailolo Channel-Maui side, 2,367 pounds (1,076 kg) for 3.0 square miles (10.2 km^2); Penguin Bank, 3,294 pounds (1,497 kg) for 3.0 square miles (10.3 km^2); Molokai, 1,784 pounds (811 kg) for 5.5 square miles (18.7 km^2); all four areas, 15,761 pounds (7,164 kg) for 15.4 square miles (52.9 km^2).

Although this standing biomass estimate of about 16,000 pounds (7,270 kg) is not impressive, it is a minimal estimate of the available resource for the following reasons. 1) There is no allowance in the estimate for trawl avoidance by the shrimp. 2) The available trawling areas of the four most productive grounds can probably be enlarged. 3) Additional trawling grounds appear available. 4) There may be movement of adults from untrawlable areas to the fishing grounds. 5) There is some evidence that this species spawns throughout the year. 6) Recruitment of young

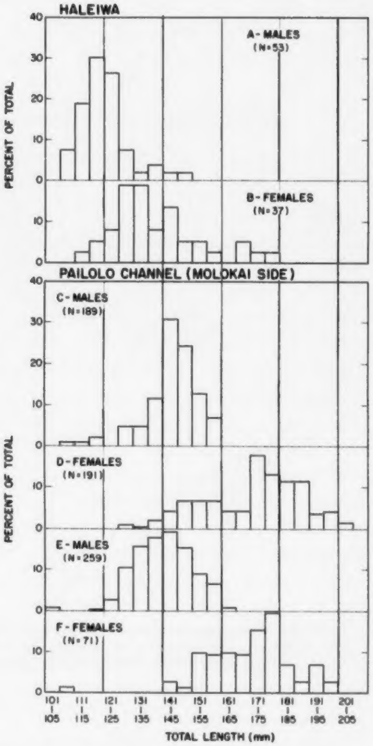

Figure 10.—*Penaeus marginatus* length-frequency data. A and B: Haleiwa area, 65-80 fathoms (118-146 m), October 1972. C and D: Pailolo Channel (Molokai side), 110-120 fathoms (201-219 m), October 1972. E and F: Same as preceding, March 1971.

could be provided by adults inhabiting untrawlable areas.

In order to gain some idea of the total magnitude of the *P. marginatus*

Table 2.—Estimated areas of seven depth ranges in the Hawaiian Islands. Units are square nautical miles and kilometers (in parentheses). See text for further explanation.

Region	Depth range: Fathoms 0-10, Meters 10-20		10-100, 20-200		100-200, 200-400		200-300, 400-600		300-400, 600-800		400- 500, 800-1,000		500-1,000, 1,000-2,000	
Leeward Islands														
Kure Is.-Laysan Is.	308	(1,056)	979	(3,358)	343	(1,176)	131	(449)	222	(761)	290	(995)	1,797	(6,164)
Maro Reef-Gardner Pinnacles	114	(391)	1,347	(4,620)	317	(1,087)	357	(1,225)	297	(1,019)	456	(1,564)	3,368	(11,552)
St. Rogatien Bank-Nihoa Is.	109	(374)	1,257	(4,312)	871	(2,988)	881	(3,021)	485	(1,664)	587	(2,013)	1,980	(6,791)
Total: Leeward Is.	531	(1,821)	3,583	(12,290)	1,531	(5,251)	1,369	(4,695)	1,004	(3,444)	1,333	(4,572)	7,145	(24,507)
Main group														
Kaula Is., Niihau, and Kauai	82	(281)	225	(772)	83	(285)	176	(604)	198	(679)	228	(782)	862	(2,957)
Oahu	105	(360)	163	(559)	127	(436)	264	(906)	265	(909)	454	(1,557)	173	(593)
Molokai	51	(175)	447	(1,533)	177	(607)	296	(1,015)	247	(847)	239	(820)	411	(1,410)
Maui	48	(165)	296	(1,015)	163	(559)	267	(916)	127	(436)	76	(261)	447	(1,533)
Lanai	13	(45)	120	(412)	133	(456)	120	(412)	213	(731)	79	(271)	127	(436)
Kahoolawe	12	(41)	77	(264)	29	(99)	16	(55)	15	(51)	16	(55)	91	(312)
Hawaii	63	(216)	274	(946)	255	(875)	232	(796)	184	(631)	256	(878)	1,096	(3,759)
Total (main group)	374	(1,283)	1,602	(5,501)	967	(3,317)	1,371	(4,704)	1,249	(4,284)	1,348	(4,624)	3,207	(11,000)
Grand total	905	(3,104)	5,185	(17,791)	2,498	(8,568)	2,740	(9,399)	2,253	(7,728)	2,681	(9,196)	10,352	(35,507)

resource, as well as for other studies, we estimated the total amount of bottom area in the Hawaiian Islands for seven depth ranges to a depth of 1,000 fathoms (2,000 m). These estimates were obtained by contouring National Ocean Survey nautical charts (nos. 4115-4117 and 4181-4183) at the desired depths and then cutting out and weighing each depth range. The weights for each depth range were converted to area by reference to the weight of a known rectangular area for each chart. Checking this method by estimating known land areas indicated an error of less than 0.1 percent. The results are given in Table 2. Due to the subjectivity in plotting the contours, we feel that simply doubling the depths in fathoms to obtain depths in meters is justified.

To estimate the amount of bottom area that could be inhabited by adult *P. marginatus* in the island areas from Oahu to Hawaii, we assumed that 35 percent and 20 percent of the bottom areas in the 10-100 fathom (20-200 m) and 100-200 fathom (200-400 m) depth ranges respectively are available to this species. This results in an estimate of about 850 nautical square miles (2,915 km^2). Using an average standing biomass estimate of 1,023 pounds per square nautical mile (135 kg/km^2) from the four most productive trawling areas results in a total biomass estimate of about 870,000 pounds (395,500 kg) of *P. marginatus*. Considering the factors discussed above, it would not seem unreasonable to assume that 50,000 to 100,000 pounds (23,000 to 46,000 kg) of this species might be harvested annually.

ACKNOWLEDGMENTS

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MFR PAPER 1170

Water Surface Area Within Statistical Subareas Used in Reporting Gulf Coast Shrimp Data

FRANK PATELLA

ABSTRACT—The water surface area (in hectares) of 21 statistical subareas was calculated for 5-fathom intervals using compensation planimeters of the polar type. A statistical analysis was done to determine the standard error and to set confidence limits on calculated values. The areas calculated are compatible with depth zones used in reporting Gulf Coast Shrimp Data and should be of value in estimating catch per unit effort per unit area.

INTRODUCTION

An essential part of analysis of any fishery is development of data on density of population and "effective fishing intensity" (Beverton and Holt, 1957). Fundamental to obtaining these data is the determination of the area over which fishing takes place, or from which fishery statistics are reported, or both.

Coastal waters adjacent to the five states bordering the Gulf of Mexico have been divided into 21 statistical subareas (Fig. 1) by the National Marine Fisheries Service (Kutkuhn, 1962). Monthly catches of shrimp (Penaeidae) recorded in the Gulf Coast Shrimp Data[1] are reported by statistical subareas, species, size class, and depth zone at 5-fathom intervals. The combination of subarea and depth zone will be referred to herein as subsubarea after Kutkuhn (1962).

[1]Current Fishery Statistics, National Marine Fisheries Service, NOAA.

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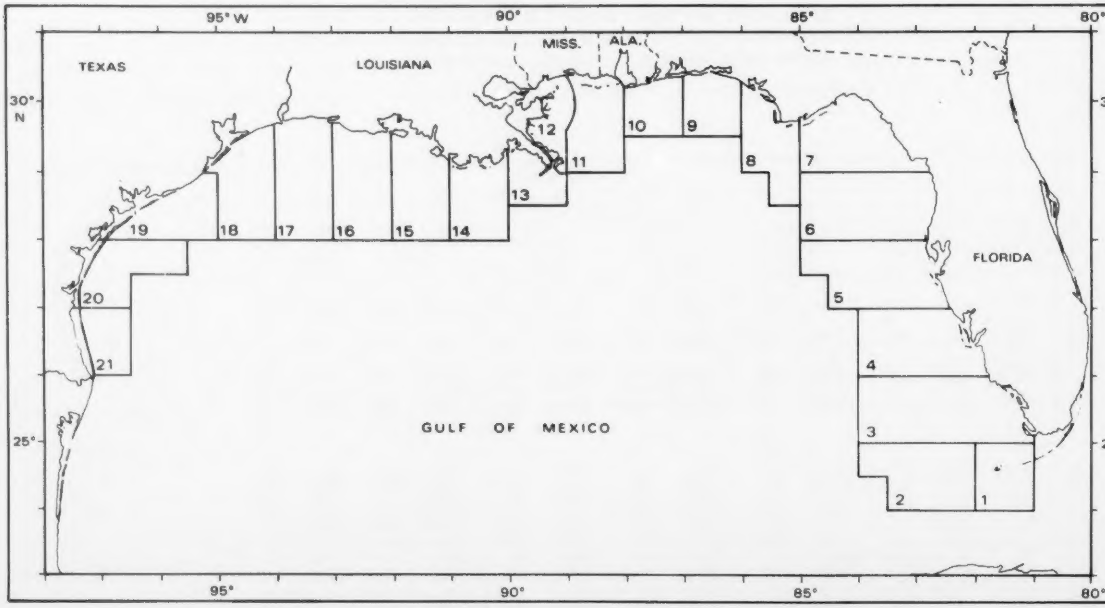

Figure 1.—Statistical subareas used in reporting Gulf Coast Shrimp Data (after Kutkuhn, 1962).

The amount of water surface area within each depth zone within each of the 21 subareas was determined with planimeter to make these data available for use with the Gulf Coast Shrimp Data on catch and fishing effort in the estimation of catch per unit effort per unit area. Water surface area can be taken as an approximation of the bottom surface area for coastal waters of the Gulf of Mexico because the bottom gradient is gradual, viz., 0.587-meter depth per kilometer horizontal distance from shore (Curray, 1960). These data also may be of use to current and future studies of abundance and distribution of other fisheries resources along the Gulf coast, especially those concerning impact of energy-related development.

Table 1.—Conversion factors (hectares per planimeter unit) used to convert average planimeter units to area in hectares for each subsubarea within each subarea.

Statistical subarea[1]	Conversion factor hectares per planimeter unit	Central latitude of 1° block[2] Degrees	Minutes	Chart number[3]
1, 2	233,621.8	24	30	1113
3	230,171.7	25	30	1113
4	228,667.8	26	30	1113
5S	223,087.5	27	30	1113
5N	231,329.7	28	00	1114
6	229,198.5	28	30	1114
7	227,736.7	29	00	1114
8, 13E	228,798.2	29	00	1115
9, 10	224,562.6	30	00	1115
11, 12	226,063.2	29	30	1115
13W, 14, 15, 16, 17	228,507.7	29	00	1116
18	228,556.1	29	00	1117
19	231,151.6	28	30	1117
20	236,176.4	27	30	1117
21	239,892.6	26	30	1117

[1]See Figure 1. N, S, E, and W indicate Northern, Southern, Eastern, and Western portions, respectively, of certain subareas.
[2]Position of the center of the statistical subarea.
[3]National Ocean Survey 1100 Series offshore navigational charts.

METHODS

Water surface areas were measured with a planimeter on tracings of National Ocean Survey 1100 Series offshore navigational charts (Mercator projections). Initially, the statistical subareas were transferred onto a tracing paper overlay. Then the depth zone contour lines were added at 5-fathom intervals. All odd-numbered depth contours were drawn after interpolation of positions between appropriate soundings from each chart. All 10-fathom contours up to 50 fathoms were traced directly from the charts. Each subsubarea was traced three times with either an Aristo[2] 1130 or Bruning-Ott planimeter, and the three planimeter readings were averaged. Both are compensation planimeters of the polar type.

Conversion of planimeter measurements to hectares required several steps.

1) For each statistical subarea, the length (longitudinally) and width (latitudinally) of a 1° block were taken from oceanographic tables (LaFond, 1951) at the parallel that passed through the center of the statistical subarea. Multiplication of the length and width gave the area, in square kilometers, of the 1° block. Square kilometers were converted to hectares.

2) For each statistical subarea, the 1° block was traced three times with planimeter, and the three values were averaged.

3) For each statistical subarea, division of the calculated area of the 1° block by the average planimeter value for the block produced a conversion factor in terms of hectares per planimeter unit. These conversion factors are summarized in Table 1.

[2]Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

Table 2.—Water surface area (hectares[1]) within statistical subsubareas used in reporting Gulf Coast Shrimp Data.

Statistical subarea	Depth zone (subsubarea) Meters: 0-9.1 Fathoms: 0-5	9.1-18.3 5-10	18.3-27.4 10-15	27.4-36.6 15-20	36.6-45.7 20-25	45.7-54.9 25-30	54.9-64.0 30-35	64.0-73.2 35-40	73.2-82.3 40-45	82.3-91.4 45-50	91.4 [2]50	Total
1	314,688.6	137,603.2	11,914.7	3,971.6	3,737.9	4,672.4	4,672.4	4,906.1	7,242.3	8,176.8	548,777.6	1,050,363.6
2	83,870.2	130,594.6	228,715.7	164,236.1	63,778.8	75,459.8	95,317.7	226,145.9	43,220.0	27,333.9	823,283.2	1,961,955.9
3	439,167.6	424,897.0	336,280.9	368,735.1	202,781.3	252,498.4	303,136.1	288,635.3	86,544.6	44,883.5	283,801.7	3,031,361.5
4	112,733.2	311,445.5	288,578.8	285,834.7	227,981.8	273,715.4	208,316.4	151,606.8	76,375.0	69,515.0	128,282.6	2,134,385.2
5	109,081.6	210,373.7	216,911.4	248,681.0	263,911.4	335,080.8	147,786.1	111,432.2	105,581.9	53,430.0	471,794.4	2,274,064.5
6	326,607.9	299,945.2	407,285.7	577,426.7	255,861.2	207,271.1	128,656.4	92,520.6	31,324.6	22,207.9	97,867.8	2,446,975.1
7	483,257.3	503,981.3	411,064.7	253,773.8	29,225.5	—[3]	—	—	—	—	—	1,681,302.6
8	76,343.1	73,673.0	258,159.9	225,212.9	124,923.8	69,250.4	68,715.0	24,481.4	28,599.8	25,396.6	297,131.1	1,271,887.0
9	4,240.8	14,895.2	155,323.2	110,035.7	94,915.9	54,867.4	34,733.1	36,902.4	40,645.8	20,136.5	354,058.9	920,754.9
10	18,937.4	91,695.6	164,678.5	187,285.2	113,404.1	33,235.3	33,909.0	22,831.3	21,632.1	9,056.6	134,962.1	831,627.2
11	59,380.0	234,504.4	169,095.3	150,632.7	137,672.5	88,465.3	75,882.6	42,499.9	24,867.0	20,646.4	318,448.5	1,322,094.6
12	79,271.3	16,805.5	2,561.3	1,055.7	1,130.3	300.7	113.0	45.2	—	—	—	101,283.0
13	65,660.8	74,039.3	37,173.4	37,859.1	39,687.7	37,402.5	32,834.9	22,167.8	21,710.5	30,167.1	300,852.0	699,555.1
14	98,790.7	235,059.0	131,316.5	93,535.1	92,164.0	82,872.9	57,887.9	50,575.6	30,163.0	35,265.6	247,549.2	1,155,179.5
15	438,124.7	170,923.8	156,680.9	108,465.7	91,478.5	77,692.6	95,820.1	71,979.9	58,801.9	55,374.3	136,800.7	1,462,143.1
16	221,424.0	299,955.2	262,630.8	260,041.8	105,417.5	142,056.4	138,857.3	90,564.5	55,070.4	44,245.9	83,496.7	1,703,760.5
17	129,031.4	524,806.8	434,925.6	156,223.9	136,266.0	104,352.6	151,957.6	109,073.6	47,682.7	34,504.7	35,881.0	1,864,705.9
18	79,919.2	513,641.0	268,553.4	189,777.0	194,576.7	163,874.7	119,916.5	40,836.1	685.7	25,671.4	—	1,597,451.7
19	64,415.0	240.090.2	371,999.2	249,643.7	138,998.4	100,012.4	29,663.7	7,010.8	5,623.9	—	—	1,207,457.3
20	23,617.6	103,445.3	182,014.1	157,057.3	125,251.4	133,281.4	166,818.5	94,470.6	93,053.5	51,094.4	212,242.3	1,342,346.4
21	17,512.2	88,112.6	101,635.3	118,826.0	190,155.7	98,276.8	75,966.8	35,904.7	28,468.0	26,467.4	59,414.2	840,739.7

[1]One hectare = 0.00386 square statute miles.
[2]Represents all remaining area of the statistical subarea beyond 50 fathoms.
[3]— = Exceeds subarea depth range.

4) Multiplication of the average number of planimeter units in each subsubarea by the corresponding hectares per planimeter unit for the appropriate subarea (Table 1) gave the estimated hectares in each subsubarea.

RESULTS AND DISCUSSION

The estimated water surface areas of statistical subsubareas are shown in Table 2. There were at least three sources of error in estimating these areas: 1) possible errors in the original charts; 2) possible errors in delineating statistical subareas and depth contours; and 3) possible errors in the planimeter measurements. There were no measures of the first two types of errors. With regard to planimeter measurements, Willers (1948) states that the back and forth oscillations of free hand tracing with a planimeter cancel each other.

In the course of this work, 225 groups of triplicate planimeter readings were analyzed to determine the precision of the measurements. To determine whether or not calculated means and variances of the triplicates were independent, the means and variances were transformed to logarithms (base 10), and a correlation analysis of $\log_{10}$(variance) vs. $\log_{10}$ (mean) was conducted (see Taylor, 1961). Though the correlation coefficient, $r = 0.18$, differed significantly ($P<0.05$) from zero, the correlation was not a strong one, and it was not considered to be of practical significance. Therefore, a single-classification analysis of variance was conducted on the 225 triplicates to estimate a pooled variance of 0.0000125 planimeter units. This gives a standard error (for a triplicate mean) of 0.00204 planimeter units which can be converted to hectares with factors in Table 1 and used to set confidence limits on values in Table 2, if desired.

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MFR PAPER 1171

Shrimp taste and vitamin content did not differ markedly in thermal and microwave processing tests.

Thermal and Microwave Energy for Shrimp Processing

M. R. R. RAO and A. F. NOVAK

INTRODUCTION

Development of new methods of processing foods inevitably encourages consumers as well as scientists to question the effects of the method on the nutrient composition of foods. Microwave cookery is actually the first totally different method of heating foods since the discovery of the attributes of fire. Since the inception of cooking by high-frequency radio waves (about 1944) scientists have attempted to elucidate its effects on food composition and total biological systems with no conclusive results.

Thermal and nonthermal effects of microwaves on microorganisms and organic chemicals were studied by Olsen, Drake, and Bunch (1966). Lacey et al. (1965) reported considerable reduction in microbial counts and even sterility in some cases when bacteria were subjected to comparatively lower levels of heat by microwaves rather than by conventional heat treatments. Proctor and Goldblith (1948) studied radar energy and its effects on the vitamin content of food products. Since then, considerable effort has resulted in numerous investigations with a great variety of conclusions. The problems seem to involve a lack of uniformity in methods of analyses, cooking times, and processing temperature.

Although much work has been done on vitamin analyses of vegetables cooked by microwaves and conventional means, literature is insufficient on proteins, and no data has yet been reported on the effects of processing methods on vitamin content of Gulf Coast shrimp.

The purpose of this study was to determine the vitamin content of shrimp processed by microwave cooking and conventional boiling and to compare these values to an uncooked (raw) control. Cooking times were established by sensory evaluation to insure that products were cooked uniformly. This method compensated for the lack of temperature measuring devices in the microwave oven. Care was taken to prevent overheating in certain areas of the microwave cavity, termed hot spots, by employing periodic stirring. Vitamins selected for this study were those which had been reported in previous microwave research, and standard methods of analyses were used for all determinations.

Microwave processing is a well-established method in the food industry and is now spreading to many different fields. Due to its greater efficiency, economical superiority, and extreme speed it has become a multimillion dollar industry within the past 10 years. It has undoubtedly influenced major changes in industrial processes, procedures, equipment, and products. Familiarity with its capabilities and potential uses in food processing industries has become increasingly vital.

MATERIALS AND METHODS

Samples

Three different sets of shrimp were obtained for analyses. Lot I was received 10 August 1969, from a large fisheries dealer (Booth Fisheries[1], Brownsville, Tex.) and consisted of one case of peeled and deveined shrimp (12/12 oz). Lot II consisted of 3 lb headless shrimp purchased 27 October 1969, from a local retailer in Baton Rouge, La. This lot was washed and treated by each processing method before being packaged and sealed in plastic bags. Lot III was obtained from a commercial dealer in New Orleans, La., 26 November 1969, and immediately transported to the Food Science Department, Louisiana State University, where the shrimp were headed, washed, and treated by each processing method before being heat-sealed in plastic bags.

Processing Methods and Equipment

Raw Samples

After each lot was washed, the control samples were packaged in 50 g quantities in heat-sealable plastic bags.

Boiled Samples

One hundred grams of shrimp were placed in an aluminum pot containing 1 liter of boiling water and 5 g salt. After 3 min and 45 sec the water returned to a boil and the shrimp were then cooked for 5 min and 30 sec at 101°C. They were then allowed to cool before peeling and packaging 50 g quantities in heat-sealable plastic bags.

Microwave Samples

One hundred grams of shrimp were placed in a heat resistant Nalge container with 1 liter of tap water (26°C) and 5 g salt and cooked with a microwave oven for 3 min, allowed to set for 10 sec, processed 30 sec, allowed to cool 10 sec, and then cooked an additional 30 sec (101°C). These time lags were to prevent boil-over. The oven used in this experiment was the Superange 2500 and its specifications are given in Table 1. Both magnetrons were used in all experiments producing 2,500 W. All samples, having been processed and packaged, were rapidly frozen to −20°C for storage until needed for analyses.

Sensory Evaluation

The organoleptic panel consisted of 10 graduate students, 9 males and 1 female. The panelists ranged in age from approximately 20 to 31 years. No

[1]Mention of trade names, commercial products, or firms does not imply endorsement by the National Marine Fisheries Service, NOAA.

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Table 1.—Specifications of Superange 2500.

Net weight	190 lb
Power required	208 or 240 volts AC, 3-wire, single-phase 30 amp circuit, 60 hertz
Power consumption	5,450 watts (both magnetrons) 3,010 watts (single magnetron) 550 watts (idle)
Power output	2,500 watts (both magnetrons) 1,250 watts (single magnetrons)
Frequency	2,450 megahertz
Power cord	6-foot, 3-wire grounding type with standard 30 amp connector
Cavity dimensions	Height 15⅛ in Width 20⁵⁄₁₆ in Depth 16⅜ in
Door dimensions	Height 17⁵⁄₁₆ in Width 22⅝ in Depth 1¼ in

effort was made to select panelists for their sensory acuity, since organoleptic differences detectable by the average untrained person were desired.

Hedonic, paired-comparison tests were used to determine the cooking times given above. The samples of cooked shrimp were scored on a 5 point hedonic scale with 1 representing poor and 5, excellent. When the hedonic scores indicated that the thermal and microwave products were equivalent in organoleptic values and palatability scores, the cooking times were recorded and used for preparing the samples used in vitamin assays.

The total cooking time for the boiled samples was 9.25 min at 101°C; that for the microwave samples was 4 min with no prior heating of the water. The final temperature of the microwave samples was 100°C and was determined immediately after the power was turned off.

Vitamin Analyses

For each vitamin assay, a 50 g sample package of each processing method and the raw control were allowed to thaw and then homogenized in a Sorvall Omni-Mixer with the proper solvent for that test. All microbiological assays were carried out according to Difco Manual (1967). Preparations of samples for analyses were according to procedures listed in Association of Official Agricultural Chemists (AOAC) (1960).

Vitamin A and ß-carotene

Procedures found in AOAC (1960), with modifications, were followed in the analyses of Vitamin A and ß-carotene. One-tenth gram of USP vitamin A and 1 g Crisco oil were weighed and treated as a 10 g simulated shrimp sample. Twenty-five grams of each shrimp sample were also weighed and a 3 to 1 volume/volume solution of ethanol and potassium hydroxide (50 g diluted in 100 ml distilled water) were added to each sample in a 4 to 1 volume/weight ratio. All samples were refluxed 30 min, cooled, and filtered through glass wool. After the volume of each sample was read, they were washed with hexane 3 times in separatory funnels and the hexane phase retained. The hexane phase was washed with water in separatory funnels until it was neutral to phenolphthalein. The vitamin A standard was diluted to 250 ml with hexane while the other samples were evaporated to dryness in a Rinco Rotary evaporator.

Columns for column chromatography were prepared as directed in AOAC (1960). ß-carotene was eluted with 30 ml of 4 percent acetone in hexane (35 ml). For vitamin A analysis, suitable aliquots were evaporated to dryness in Spectronic 20 tubes and 1 ml of choloroform was added. After 4 ml antimony trichloride (Carr-Price) reagent was added to sample tubes they were read immediately for maximum deflection due to rapid fading. The amount of vitamin A was determined by using a standard curve prepared by increasing the concentration of the vitamin A standard. A standard ß-carotene curve was prepared by using a series of dilutions of ß-carotene in hexane and plotting absorbance against μg carotene. Vitamin A was read at 620 mμ on a Bausch and Lomb Spectronic 20 and carotene was read at a wavelength of 440 mμ.

Stock Cultures for Microbiological Assay of Vitamins

Cultures of *Lactobacillus arabinosus* 17-5 ATCC 8014 (plantarum), *Lactobacillus fermentum* 36 ATCC 9833, and *Lactobacillus casei e* ATCC 7469 were received in July 1969 and were revived 5 September 1969 by placing them in Bacto-Micro Inoculum Broth and incubating them 48 h at 37°C. Stabs were then made in triplicates in Bacto-Micro Assay Culture Agar and after 48 h incubation, were stored in a refrigerator at 2-6°C. Stock cultures were transferred each week for 1 month and thereafter were transferred each month. A gram stain and streak plate were made of all stabs to insure pure cultures.

Riboflavin

The test organism in this assay was *Lactobacillus casei e* (7469). Assay standard and sample tubes were set up according to Difco Manual (Difco Laboratories, 1967) and after 18 h were read turbidometrically by a Bausch and Lomb Spectronic 20. Extraction procedures were those of AOAC (1960) with modifications. Ten grams of each sample were hydrolyzed in 150 ml 0.1 N hydrochloric acid and autoclaved 30 min at 121°C, 15 lb pressure, and then adjusted to a pH of 6.8 with 1 N sodium hydroxide. The volume was then brought to 200 ml with distilled water and centrifuged in 50 ml tubes to rid the solution of the protein precipitate. One, two, three, etc., ml of the sample were added to sample tubes and then all tubes were inoculated and incubated for 18 h.

Niacin

Procedures given in the Difco Manual (Difco Laboratories, 1967) were used for the microbiological assay of niacin. *Lactobacillus arabinosus* (8014) (plantarum) was the test organism and was incubated for 24 h at 37°C in Bacto-Micro Inoculum Broth before inoculation. Samples were prepared by hydrolyzing 20 g of each sample 30 min after adding 125 ml of 1 N sulfuric acid. After cooling, the pH was adjusted to 6.8 by adding 1 N sodium hydroxide. Samples were diluted to 1,000 ml and then centrifuged with the resulting solution further diluted 1 to 10 with distilled water. The assay was sterilized by autoclaving 10 minutes at 15 lb pressure (121°C), inoculated, and allowed to incubate 18 h at 37°C. The tubes were read turbidometrically with a Bausch and Lomb Spectronic 20 at a wavelength of 650 mμ.

Thiamine

Lactobacillus fermentum (9833) was used for this assay. It was found that stock cultures must be incubated a full 48 h to produce proper results in this assay. Preparation of samples was carried out according to AOAC (1960) with slight modifications. Twenty grams were hydrolyzed in 150 ml of 0.1 N hydrochloric acid by autoclaving 30 minutes at 121°C. The pH was adjusted to 6.5 with 1 N sodium hydroxide, and the sample was then diluted to 250 ml with distilled water, centrifuged, and then further dilutions were made to attain

proper readings. Because of possible destruction of thiamine, the assay was steam sterilized at 100°C for 15 minutes before cooling and inoculating.

Pantothenic Acid

After preliminary investigations it was found that stock cultures of *Lactobacillus arabinosus* (8014) should be incubated 36 h instead of 48 h to produce proper responses. Samples were prepared by adding 220 ml of distilled water to 20 g of the sample shrimp. The pH was adjusted to 5.65 with an acetate buffer (10 ml 0.2 N acetic acid, 100 ml of 0.2 N sodium acetate in 1 liter of distilled water). After autoclaving for 7 min at 121°C the pH was adjusted with 1 N sodium hydroxide to 6.8 and the solution was diluted to 2,000 ml before centrifuging. After increasing amounts of the solution were pipetted into each tube, the assay was autoclaved 10 min at 15 lb pressure (121°C). Throughout all microbiological assays, the stock solutions of each vitamin were stored in a refrigerator at 2-6°C under toluene. All determinations were carried out by plotting a standard curve for each assay and comparing growth of sample tubes using turbidometric readings (Difco Laboratories, 1967).

Table 2.—Analysis of variance for appearance, texture, taste, and overall organoleptic scores.

Organoleptic Quality	Source of variation	Degrees of freedom	Mean square	F value
Appearance	Total	39		
	Judges	9	2.2472	[1]3.39
	Process	1	0.0250	0.04
	Replicas	1	0.2250	0.34
	Replicas × Process	1	0.6250	0.94
	Error	27	0.6620	
Texture	Total	39		
	Judges	9	1.5694	1.42
	Process	1	0.2250	0.20
	Replicas	1	0.0250	0.02
	Replicas × Process	1	1.2250	1.11
	Error	27	1.1028	
Taste	Total	39		
	Judges	9	2.1694	[2]2.26
	Process	1	0.2250	0.23
	Replicas	1	3.0250	3.14
	Replicas × Process	1	0.0250	0.03
	Error	27	0.9620	
Overall	Total	39		
	Judges	9	11.500	[1]5.68
	Process	1	1.000	0.49
	Replicas	1	1.600	0.79
	Replicas × Process	1	3.600	1.78
	Error	27	2.026	

[1]$P<0.01$
[2]$P<0.05$
Critical values at *d.f.* 9/27 $F_{0.05} = 2.25$, $F_{0.01} = 3.15$
Critical values at *d.f.* 1/27 $F_{0.05} = 4.21$, $F_{0.01} = 7.68$

Table 3.—Individual mean scores of the 10 judges in order of increasing rank for appearance, taste, texture, and overall scores.

Appearance									
Mean score	1.00	2.00	2.25	2.50	3.00				
Judge no.	4,10	3,9	1	2,7	5,6,8				
	F = [1]3.39								
Texture									
Mean score	1.25	1.75	2.00	2.25	2.50	2.75	3.25		
Judge no.	10	4	3	8,9	1,2	7	5,6		
	F = 1.42								
Taste									
Mean score	1.50	2.00	2.25	2.50	2.75	3.25	3.75		
Judge no.	5	3	4,9	10	1,8	6	2,7		
	F = [2]2.26								
Overall									
Mean score	4.75	6.00	6.50	7.50	7.75	8.00	8.75	9.00	9.50
Judge no.	4,10	3	9	1	5	8	2	7	6
	F = [1]5.68								

[1]$P<0.01$
[2]$P<0.05$
Critical value at *d.f.* 9/27, $F_{0.05} = 2.25$, $F_{0.01} = 3.14$

RESULTS AND DISCUSSION

Organoleptic Results

The organoleptic data were subjected to standard analyses of variance which examined the effects on appearance, texture, taste, and overall values of two processes and two replicas. The results of the analyses of variance are presented in Table 2.

The mean scores of the different judges are listed in Table 3 in order of increasing rank. These ranged from 1.0 to 3.0 for appearance, from 1.25 to 3.25 for texture, and from 1.50 to 3.75 for taste. The overall organoleptic scores (sum of values for appearance, texture, and taste) were highly individualistic, ranging from 4.75 to 9.50, with only 2 judges, No. 4 and No. 10, scoring the same total. The 4 calculated F values for differences among the means for the 10 judges were: appearance, 3.39, highly significant; texture, 1.42, insignificant; taste, 2.26, significant; and overall, 5.68, highly significant. The critical values at *d.f.* 9/27 are $F_{0.05} = 2.25$, and $F_{0.01} = 3.14$.

Cooking Processes

The mean organoleptic scores and standard deviations associated with the thermal and microwave processes are given in Table 4. For both processes the mean scores for appearance, texture, taste, and overall values were almost identical. The calculated F values for differences between the thermal and microwave samples were very small and insignificant, ranging from 0.04 for appearance to 0.49 for overall values. The critical value at *d.f.* 1/27 is $F_{0.05} = 4.21$.

Replicas

The mean organoleptic scores and standard deviations associated with the 2 replicas are shown in Table 5. There

Table 4.—Mean scores and standard deviations for appearance, texture, and taste among processes.

	Microwave		Boiled		F values
	Mean	S.D.	Mean	S.D.	
Appearance	2.20	1.06	2.25	0.96	0.04
Texture	2.45	1.10	2.30	1.08	0.20
Taste	2.60	1.10	2.75	1.17	0.23
Overall	7.20	2.01	7.30	2.13	0.49

Critical value at *d.f.* 1/27, $F_{0.05} = 4.21$, $F_{0.01} = 7.68$

Table 5.—Mean scores and standard deviations for appearance, texture, and taste among replicas.

	First replica		Second replica		F values
	Mean	S.D.	Mean	S.D.	
Appearance	2.30	1.13	2.15	0.88	0.34
Texture	2.35	1.18	2.40	0.99	0.02
Taste	2.40	1.04	2.95	1.14	3.14
Overall	7.05	2.23	7.45	1.88	0.79

Critical value at *d.f.* 1/27, $F_{0.05} = 4.21$, $F_{0.01} = 7.68$

appeared to be a trend toward a preference for the second replica samples in overall scores and this was especially evidenced in taste scores for which the F value was 3.14. The second replica samples were scored higher in texture, taste, and overall, with appearance being slightly higher in the first replica. The critical value at $d.f.$ 1/27 is $F_{0.05}$ = 4.21.

Interactions Between Processes and Replicas

The mean scores for the interaction, process × replica, with respect to appearance, texture, taste, and overall values of the shrimp sample are given in Table 6. The critical values of F at $d.f.$ = 1/27 for the above interactions were $F_{0.05}$ = 4.21 and $F_{0.01}$ = 7.68. The interactions between processes and replicas for each of the four organoleptic

Table 6.—Interactions—mean organoleptic scores of shrimp.

Qualities	Replica 1	Replica 2
Appearance		
Thermal	2.20	2.30
Microwave	2.40	2.00
F = 0.94		
Texture		
Thermal	2.10	2.50
Microwave	2.60	2.30
F = 1.11		
Taste		
Thermal	2.50	3.00
Microwave	2.60	2.30
F = 0.03		
Overall		
Thermal	6.80	7.80
Microwave	7.30	7.10
F = 1.78		

Critical value at $d.f.$ 1/27, $F_{0.05}$ = 4.21
$F_{0.01}$ = 7.68

attributes all had insignificant F values. This indicated that the processes and replicas were consistent in their relationships with respect to the preferences of the judges.

Correlation Coefficients

In Table 7 the values of the Pearson product-moment coefficients of correlation are given for all 6 possible pairs of organoleptic attributes (appearance vs. texture, appearance vs. taste, appearance vs. overall, texture vs. taste, texture vs. overall, and taste vs. overall) and these are categorized according to processes and replicas.

The correlations between appearance and texture were positive in all 4

Table 7.—Correlation coefficients of appearance, texture, and taste for the replicas and processes.

Correlations	$d.f.$	Replicas: First	Replicas: Second	Process: Microwave	Process: Boiled
Texture vs Appearance	18	0.114	0.351	0.190	0.227
Taste vs Appearance	18	[1]0.472	−0.202	−0.064	0.339
Taste vs Texture	18	−0.077	−0.074	−0.061	−0.063
Overall vs Appearance	18	[2]0.786	[2]0.566	[2]0.623	[2]0.754
Overall vs Texture	18	[1]0.551	[2]0.688	[2]0.646	[2]0.576
Overall vs Taste	18	[2]0.666	[1]0.500	[1]0.491	[2]0.669

[1]Significant at $P<0.05$
[2]Significant at $P<0.01$
Critical value at $d.f.$ 18, $F_{0.05}$ = 0.444
$F_{0.01}$ = 0.561

categories but they were not significant ($P>0.05$). The correlations between appearance and taste were positive for the first replica and the thermal process and were significant ($P<0.05$), whereas in the two other categories the correlations were negative and not significant. The correlations between texture and taste were negative in all 4 categories but they were not significant, whereas correlations between overall scores and appearance were positive and highly significant in all 4 categories ($P<0.01$). The correlations between overall scores and texture were positive in all categories and significant in one category (first replica) and highly significant in the three other categories: those between overall scores and taste were positive in all categories; they were significant in two categories, second replica and microwave process, and highly significant in the two other categories.

The analyses of the data indicate there were no significant differences between the microwave and boiled processes and between replicas. Significant differences were found among judges at the 0.01 level. Samples of shrimp processed according to these procedures were then analyzed for vitamin A, ß-carotene, niacin, thiamine, riboflavin, and pantothenic acid.

Vitamin Analyses

After three assays of each vitamin had been carried out, Table 8, mean values, Table 9, were calculated for the

Table 8.—Results of vitamin analysis.

Vitamin	Replicas	Process: Raw	Process: Microwave	Process: Boiled
		Micrograms per gram		
Niacin	1	12.37	13.33	15.27
	2	27.30	18.40	18.02
	3	19.88	14.40	15.75
Thiamine	1	0.95	0.82	0.81
	2	0.91	1.09	0.95
	3	0.52	0.81	0.54
Riboflavin	1	0.59	0.40	0.52
	2	1.03	0.65	0.61
	3	0.37	0.51	0.53
Pantothenic acid	1	1.50	1.47	1.30
	2	1.47	1.47	1.73
	3	2.65	3.10	1.60
ß-carotene	1	0.048	0.046	0.060
	2	0.093	0.065	0.044
	3	0.078	0.099	0.138

Table 9.—Mean vitamin content of shrimp samples.

Vitamin	Replicas: First	Replicas: Second	Replicas: Third	Process: Boiled	Process: Microwave	Process: Raw
			Micrograms per gram			
Niacin	13.66 F = 4.11	21.24	16.68	16.35 F = 1.56	15.38	19.85
Thiamine	0.860 F = 8.14[1]	0.983	0.623	0.767 F = 1.34	0.970	0.793
Riboflavin	0.503 F= 2.88	0.763	0.470	0.553 F = 0.63	0.520	0.663
Pantothenic acid	1.42 F = 4.14	1.56	2.45	1.54 F = 0.77	2.01	1.87
ß-Carotene	0.051 F = 3.04	0.067	0.105	0.081 F = 0.12	0.070	0.073

[1]Significant at $P<0.05$
Critical values at $d.f.$ 2/4, $F_{0.05}$ = 6.94
$F_{0.01}$ = 18.00

raw, boiled, and microwave processes, and, based on the raw values, apparent percent retentions were calculated. Niacin was retained by 77.48 percent in the microwave and 82.36 percent in the boiled samples; 115.00 and 97.00 percent of thiamine were retained in the microwave and boiled samples, respectively; 79.00 percent in the microwave and 83.00 in the boiled samples were retained of riboflavin; pantothenic acid had 107.00 and 82.00 percent retentions in the microwave and boiled processes; and ß-carotene had apparent percent retentions of 96.00 in the microwave and 110.00 in the boiled samples.

Vitamin A and ß-carotene

Preliminary analysis of vitamin A revealed no measurable amount present in the flesh of Gulf Coast shrimp. These results are in agreement with those of Fisher, Kon, and Thompson (1957) who found no vitamin A in the body of *Penaeus aztecus*. They found a total vitamin A content of .054 μg/g but this was made up entirely of vitamin A found in the eyes (4.3 μg/g).

ß-carotene was then measured because of its reported vitamin A activity. Stecher (1960) calls ß-carotene the most important of the provitamins A, having about one-half vitamin A activity. A substantial difference among replicas and samples may be explained by ß-carotene's tendency to oxidize when exposed to the air. Mean values of the three replicas and processes are presented in Table 9. The boiled samples were higher in ß-carotene than raw samples and the microwave samples retained 96.0 percent. The unusually high amounts of ß-carotene in the boiled samples might be explained by enzyme inactivation due to processing and could also be due to uneven oxidation. Results were similar to those given by Fisher et al. (1957) for carotenoid content.

Niacin

Although the amount of niacin changes from sample to sample, results are fairly consistent among each replica. Table 9 gives the mean values for the 3 replicas and processes. Samples processed by microwaves retained 77.48 percent and the boiled samples retained 82.36 percent. These figures generally agree with other results which indicate 80-90 percent retention of niacin due to processing temperatures. General vitamin content was in agreement with results shown by Heen and Kreuzer (1962) who recorded values of 11-53 μg/g for shrimp. An analysis of variance will be discussed for all vitamins following discussion of their individual characteristics.

Thiamine

This assay seemed to be the most difficult to run due to the fastidious nature of the test organisms. Results of the 3 replicas were consistent (Table 8) except for the third replica. Mean values (Table 9) once again showed a B vitamin with higher values in one of the processed samples than in the raw samples. The mean values for the microwave and boiled samples had 115.0 and 97.0 percent retention respectively. This is possibly explained by Furia (1968) when he stated that enzymes capable of destroying vitamin B_1 (thiaminase) occur in some foods—raw fish, clams, shrimp, rice polishings, beans, and mustard seed. Thiamine was found to be heat labile by Inagaki, Hishio, and Hattori (1964), Goldblith, Tannenbaum, and Wang (1968), and Causey and Fenton (1951) in meat and vegetables. When shrimp were tested the raw samples were allowed to sit at room temperature while the microwave and boiled processes were carried out. There was also a time lag for packaging all samples, and after freezer storage samples were thawed for analyses. Melnick, Hochberg, and Oser (1945) reported that within 20 min one serving of raw clams (100 g) could destroy 7.5 mg of thiamine, whereas a heated clam serving destroyed only 15 percent of the 8 mg of thiamine originally present. The thiaminase enzyme in raw clams was inactivated during processing allowing similar results in both the cooked and raw samples. The greater amount of thiamine in the microwave samples could be due to a higher degree of destruction of thiaminase than that due to just thermal energy.

Riboflavin

Results of the 3 replicas (Table 8) are inconsistent among some replicas and processes, although values agree with ranges of riboflavin in shrimp given by Heen and Kreuzer (1962). Percent retention based on mean values (Table 9) was 79.0 percent for the microwave and 83.0 percent for the boiled samples. This agrees with results cited in the literature review. Furia (1968) noted retentions of 70-90 percent in meat depending on methods of cooking and he also stressed the fact that riboflavin is light sensitive which could be a factor in some samples even though attempts were made to reduce this factor.

Pantothenic Acid

Results of the vitamin analyses (Table 8) showed a slight inconsistency in the third replica. All values were well within the range of pantothenic acid given for shrimp flesh by Heen and Kreuzer (1962), 1.2-3.8 μg/g, and values given by Orr (1969), 2.8 μg/g.

Table 9 shows mean values of the 3 replicas to be similar in relationship to those of thiamine. Microwave samples retained 107.0 percent and the boiled samples retained 82.0 percent when compared to the raw control. Furia (1968) shows a 7-10 percent loss of pantothenic acid when meat is cooked, but also states that there is usually only 70 percent retention when foods are cooked in an excess amount of water due to the vitamin's hygroscopic nature. The greater amounts of pantothenic acid in the microwave sample could be due once again to enzymatic action in the other samples, experimental error for the method of assay, or microbiological activity.

Analysis of Variance

Table 10 gives an analysis of variance for all vitamins previously discussed, along with ß-carotene, the provitamin

Table 10.—Analysis of variance on vitamin composition due to replicas and processes.

Vitamin	Source of variance	Degrees of freedom	Mean square	F value
Niacin	Total	8		
	Replicas	2	43.730	4.11
	Processes	2	16.612	1.56
	Error	4	10.650	
Thiamine	Total	8		
	Replicas	2	0.1004	[1]8.14
	Processes	2	0.0166	1.34
	Error	4	0.0123	
Riboflavin	Total	8		
	Replicas	2	0.0774	2.88
	Processes	2	0.0169	0.63
	Error	4	0.0268	
Pantothenic acid	Total	8		
	Replicas	2	0.9349	4.14
	Processes	2	0.1747	0.77
	Error	4	0.2260	
ß-Carotene	Total	8		
	Replicas	2	0.00228	3.04
	Processes	2	0.000091	0.12
	Error	4	0.000749	

[1]Significant at $P<0.05$
Critical value at *d.f.* 2/4, $F_{0.05} = 6.94$
$F_{0.01} = 18.00$

A. The sources of variation for each vitamin were the 3 replicas and the 3 processes. The only significant difference, which was found in the replicas for thiamine, was significant at the 5 percent level. The *F* values were consistently higher for replicas than for processes. The small number of replicas and the large differences between them undoubtedly contributed to the finding of only insignificant differences among the raw and processed samples of shrimp.

As discussed in sections covering individual vitamins, many of these differences in replicas could be caused by several factors. Novak, Fieger, and Bailey (1956) offered experimental error, microbiological activity (synthesis of additional vitamins), enzymatic degradation, and sampling errors as reasons for fluctuation of vitamin content.

An evaluation of findings in this study indicates that no difference in sensory evaluation and no significant differences in vitamin retention between the microwave and thermal methods are evident. Therefore, it is concluded that the faster, labor saving method of microwave cookery could be utilized with no sacrifice of nutritional or organoleptic qualities to the consumer. It is hoped that this present study will add to the knowledge being accumulated on microwave cookery.

High frequency cooking has a definite place in the future, and restaurants are now operating with complete precooked, frozen, and microwave-thawed gourmet dinners. With institutional, industrial, and domestic uses increasing each day, there is no doubt that microwave cooking will play an important part in the food industry of the future.

SUMMARY

Gulf Coast shrimp were processed by 2450 MHz microwave energy and conventional boiling to determine if differences existed in organoleptic evaluation and vitamin retention. Since no satisfactory method was available for measuring the temperature of products while being cooked by microwave energy, hedonic test panels were employed to insure compatible cooking times for the two methods. A 10-member panel evaluated these methods by scoring a 5-point hedonic test for appearance, texture, and taste.

Chemical tests for vitamin A and ß-carotene, and microbiological assays for niacin, thiamine, riboflavin, and pantothenic acid were used to determine vitamin retention. Statistical analyses of all results were accomplished with the use of a 360 IBM computer. Results of the organoleptic tests showed no significant difference between the two processes; the only significant difference was among the judges, showing evidence of an untrained test panel which is typical of the consuming public.

Vitamin A was not found in the tailmeat and thereafter samples were analyzed for ß-carotene, one of the most important provitamins A. Apparent percent retentions were calculated from the mean values of the replicas for each vitamin and varied between 77.48 and 115.0 percent for different vitamins and processes and were based on values found for the raw control. The highest value, 115.0 percent, was found in the microwave samples assayed for thiamine, and was probably caused by thiaminase found in raw shrimp, which is responsible for destruction of thiamine.

Analysis of variance for vitamin composition showed no significant difference between processing methods, although there was a significant difference at the 0.05 level for replicas in the thiamine assay.

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MFR PAPER 1172

The Atlantic Coast Surf Clam Fishery—1973

JOHN W. ROPES, ARTHUR S. MERRILL,
and GEORGE E. WARD

ABSTRACT—The 1973 Atlantic coast surf clam fishery produced landings of 82.3 million pounds of meats, 19.0 million pounds more than in 1972. Landings at Virginia ports were 85 percent higher than in 1972 and amounted to over half of the United States total. Landings at other middle-Atlantic coast ports were generally similar to 1972.

INTRODUCTION

Landings of clams in the United States have increased since World War II and most of the increase has been from the surf clam resource of the Middle Atlantic Bight. Ropes (1972) summarized annual reports for 1965-69. The reports included information that surf clams provided meats for more than half of the United States clam products during this period. Annual reports for 1970-72 continued to give details of this important fishery, changes in landings, areas fished, and fleet activities (Ropes and Barker, 1972; Ropes, Barker, and Ward, 1972, 1975). These reports show that landings of surf clams have greatly surpassed the combined totals for traditional species, such as soft-shelled clams (*Mya arenaria*) and hard-shelled clams (*Mercenaria mercenaria*). In 1973, surf clams supplied 80 percent of the United States total of clam meats by weight. A sharp increase in Virginia landings was responsible for the record catch.

INFORMATION SOURCE

Landings data in the Middle Atlantic Bight were supplied by the National Marine Fisheries Service, Division of Statistics and Market News. Landings by vessel are generally obtainable at each port from New York through Maryland. In Virginia, only the total landings for the State are available, but base ports for vessels are known and included.

Interviews by port samplers provided specific information on fishing areas, catch, and effort in Maryland and Virginia. No interview records were obtained for vessels fishing off New York, New Jersey, and Delaware, but from personal conversations with industry representatives and vessel captains it appears that no significant new fishing areas were added to those reported for 1972 (Ropes et al., 1975).

FLEET OPERATIONS AND LANDINGS BY AREA

The number of vessels in the surf clam fleet in 1972 and 1973 and the landings by area are presented in Table 1. In 1973 a total of 98 vessels, a decrease of 2 from 1972, made up the surf clam fishing fleet in the Middle Atlantic Bight. The Virginia fleet decreased, by 2, to 21 vessels. One vessel was based at Chincoteague, four at Oyster, one at Kiptopeke, eleven at Cape Charles, and four at Little Creek. The Division of Statistics and Market News observed that as many as 41 vessels used the Virginia ports at various times. The additional 20 vessels were migrants to the area from more northern ports. The Maryland fleet consisted of 17 vessels—1 less than in 1972. Two very efficient vessels landed their catch in Delaware, although their home port was Cape May-Wildwood. The New Jersey fleet consisted of 51 vessels. Thirty vessels were based at Cape May-Wildwood—4 fewer than in 1972; 13 at Point Pleasant—an increase of 1; and 4 vessels shifted to Atlantic City to double the fleet at 8. The New York fleet, based mostly at Freeport, Long Island, remained at 7 vessels. Three vessels from the Point Pleasant fleet quit clamming, 1 sank off Virginia, and 2 new vessels were added (1 in Maryland and 1 in Virginia) to the total fleet in 1973. This resulted in a net loss of 2 vessels.

Table 1.—Surf clam vessels and landings by area (1972-73).

	Number of vessels		Landings (Million lb)	
Area	1972	1973	1972	1973
Chincoteague to Norfolk, Va.	23	[1]21	23.4	43.3
Cape May-Wildwood, N.J.	34	30	14.8	12.5
Ocean City, Md.	18	[1]17	7.3	7.5
Lewes, Del.	2	2	8.6	6.6
Point Pleasant, N.J.	[2]12	[2]13	4.8	4.1
Atlantic City, N.J.	4	8	1.4	4.7
Long Island, N.Y.	[3]7	[3]7	2.6	3.2
Total	100	98	[4]62.9	[5]81.9

[1]Includes one part-time clammer.
[2]Includes one bait clam vessel.
[3]Includes two bait clam vessels.
[4]Total is less 0.452 million pounds of bait.
[5]Total is less 0.338 million pounds of bait.

Landings of 81.9 million pounds of meats were 19.0 million pounds (30 percent) higher than in 1972 (Table 1). Virginia landings increased 85 percent over those reported for 1972, from 23.4 to 43.3 million pounds, nearly double the previous year. Monthly catches ranged from 2.3 to 3.9 million pounds and averaged 3.6 million pounds (Fig. 1). Maryland landings of 7.5 million pounds were higher than in 1972, but by only 3 percent (0.2 million pounds). Monthly catches ranged from 0.3 to 0.8 million pounds and averaged 0.6 million pounds. Delaware landings of 6.6 million pounds were 2.0 million pounds lower than in 1972; monthly catches ranged from 0.5 to 0.9 million pounds and averaged 0.6 million pounds. New Jersey landings of 21.3 million pounds were 0.3 million pounds (1 percent) higher than in 1972. Ports of landing were at Cape May-Wildwood, Point Pleasant, and Atlantic City. Landings at Cape May-Wildwood were 2.3 million pounds lower than in 1972. This port has supplied more than half of the New Jersey landings since 1967 and its

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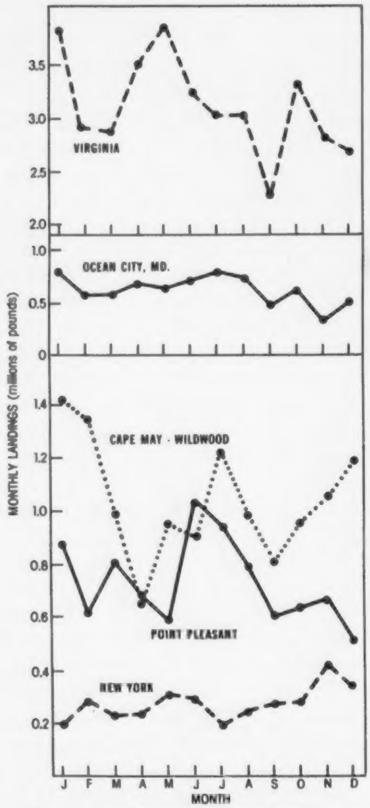

Figure 1.—Monthly 1973 landings of surf clams at ports in Virginia, Maryland, New Jersey, and New York.

contribution was 58 percent (12.5 million pounds) in 1973. Monthly catches were from 0.6 to 1.4 million pounds, averaging 1.0 million pounds. Vessels at Point Pleasant landed 4.1 million pounds. The decrease at this port was 0.7 million pounds; monthly catches were from 0.2 to 0.5 million pounds, averaging 0.4 million pounds. Vessels at Atlantic City, however, landed 4.7 million pounds, a threefold (3.3 million pound) increase over 1972. Monthly landings were from 0.2 to 0.6 million pounds and averaged 0.4 million pounds. The increase at Atlantic City more than compensated for the lower landings at Point Pleasant and Cape May-Wildwood. If the Delaware landings are added to those of New Jersey, since the vessels fished mostly the same grounds, the combined catch equals 27.9 million pounds or 34 percent of the 1973 total. New York landings of 3.2 million pounds were 0.5 million pounds higher than in 1972. Monthly landings were from 0.2 to 0.4 million pounds, averaging 0.3 million pounds.

In summary, Virginia landings were 53 percent of the 1973 total, New Jersey 26 percent, Maryland 9 percent, Delaware 8 percent, and New York 4 percent. By contrast, 1972 landings by the respective states were 37 percent, 33 percent, 12 percent, 14 percent, and 4 percent.

FISHING STATISTICS FROM INTERVIEWS

Interviews were obtained from vessel captains monthly at Oyster, Kiptopeke, and Cape Charles ports in Virginia and twice each month at the Ocean City port in Maryland from April through December, 1973. This activity resulted in a total of 82 and 210 records for the respective states. These records gave locations of vessel fishing operations, number of bushels of clams taken during the fishing trip, depths fished, hours spent fishing, and the size composition of the catch. Figure 2 shows 1,025 square nautical miles of ocean with intensity of vessel operations plotted on 5 × 5 nautical mile areas. Vessels from Virginia ports fished in 12 of the southernmost areas and those from Maryland fished in 29 of the northernmost areas. From 1 to 29 vessels operated in an area during the sampling period. The average number of trips per area was 6.6, or 0.3 trip per square mile. As a scale of intensity of fishing, less than 0.1 trip per square mile (1-2 trips per area) indicated light fishing activity, from 0.1 to 0.6 trip per square mile (3-15 trips per area) moderate fishing activity, and more than 0.6 trip per square mile (16+ trips per area) heavy fishing activity. The Virginia fleet fished most intensely in a 50 square mile area, moderately in a 75 square mile area, and lightly in a 175 square mile area. Maryland vessels concentrated in a 100 square mile

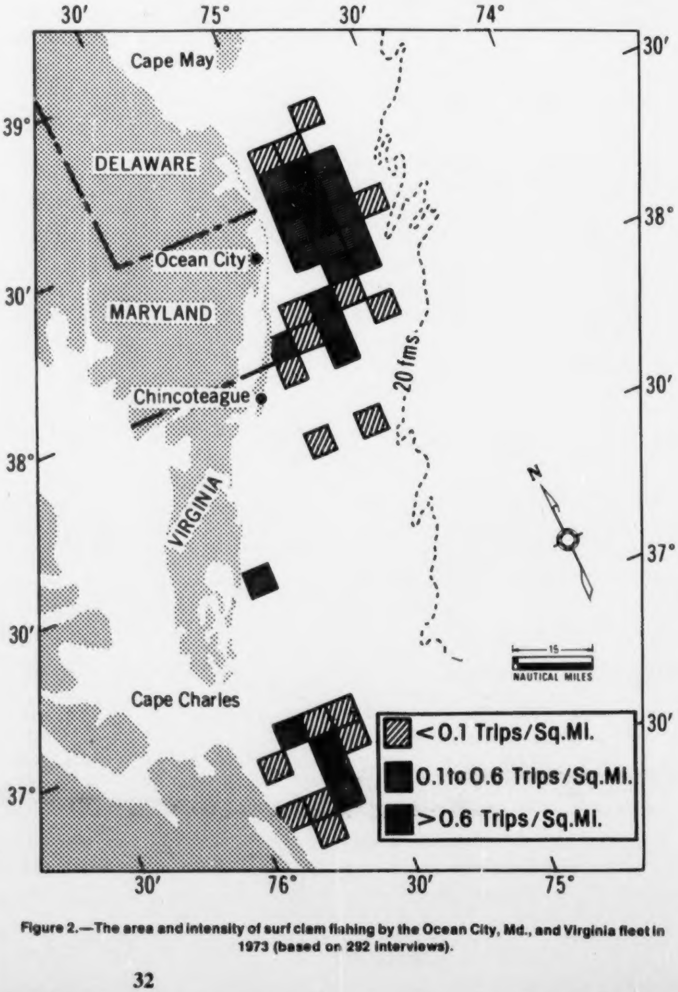

Figure 2.—The area and intensity of surf clam fishing by the Ocean City, Md., and Virginia fleet in 1973 (based on 292 interviews).

area, fished moderately in a 350 square mile area, lightly in a 275 square mile area.

Vessels interviewed from Virginia operated in fishing areas at depths of 10.7 to 22.9 m (35-74 feet), averaging 18.3 m (60 feet); in Maryland at depths of 9.1 to 29.2 m (30-90 feet), averaging 19.5 m (64 feet). Catch rates for Virginia and Maryland are shown in Figure 3. In Virginia catch rates of more than 200 bushels per hour were reported at 3 fishing areas, 100 to 199 bushels per hour at 7, and 49 bushels or less at 1 fishing area; the mean catch per hour ranged from 84 to 320 bushels (1,428-5,440 pounds) and the average was 165 bushels (2,805 pounds). In Maryland all catch rates averaged less than 49 bushels; the mean catch per hour ranged from 13 to 37 bushels (221-629 pounds) and the annual average was 23 bushels (391 pounds).

Figure 4 shows the mean shell lengths by fishing areas to be higher in Maryland than in Virginia. In Maryland the mean shell length from 4 areas was over 170 mm and in the remaining 25 areas ranged between 133 and 170 mm. In Virginia mean clam sizes in 6 areas ranged from 133 to 170 mm and in 5 areas were less than 133 mm. The 2 areas where the catch rate was highest (Fig. 3) contained clams with means less than 133 mm (Fig. 4).

In Virginia, day trip effort for the vessels interviewed ranged from 1.5 to 24 hours per day of fishing time; monthly averages were 7.4 to 10.4 hours (Fig. 5); and the annual average was 8.8 hours per day. Landings per trip were 80 to 3,200 bushels (1,360-54,440 pounds of meats), averaging 956 bushels (16,252 pounds). Monthly mean catch rates per hour ranged from 85 bushels (1,455 pounds) to 147 bushels (2,499 pounds), averaging 120 bushels (2,040 pounds), up 1.3 bushels (24 pounds) from 1972. Low trip landings and effort, as in earlier years, were often the result of gear breakdown which curtailed normal fishing operations. Clam lengths ranged from 86 to 170 mm (3.4-6.7 in); monthly mean lengths ranged from 133 to 139 mm (5.2-5.5 in), averaging 135 mm (5.3 in), up 2 mm from 1972.

In Maryland day trip effort for the vessels interviewed ranged from 3 to 13 hours; monthly averages ranged from 5.3 to 9.3 hours (Fig. 5); and the annual average was 7.8 hours. Landings per trip were 30 to 360 bushels (510-6,120 pounds of meats), averaging 173 bushels (2,941 pounds). Monthly mean catch rates per hour were 19-25 bushels (323-425 pounds), averaging 22 bushels (374 pounds), down 5 bushels (85 pounds) from 1972. Clam lengths ranged from 107 to 198 mm (4.2-7.8 in), averaging 161 mm (6.3 inches). Monthly mean lengths were consistently 150 mm or higher (151-167 mm or 5.9-6.6 inches) indicating most clams were taken from offshore beds. This fleet averaged 0.2 more hours of fishing time per trip in 1973 than 1972 and concentrated on offshore beds, which resulted in fairly stable catches.

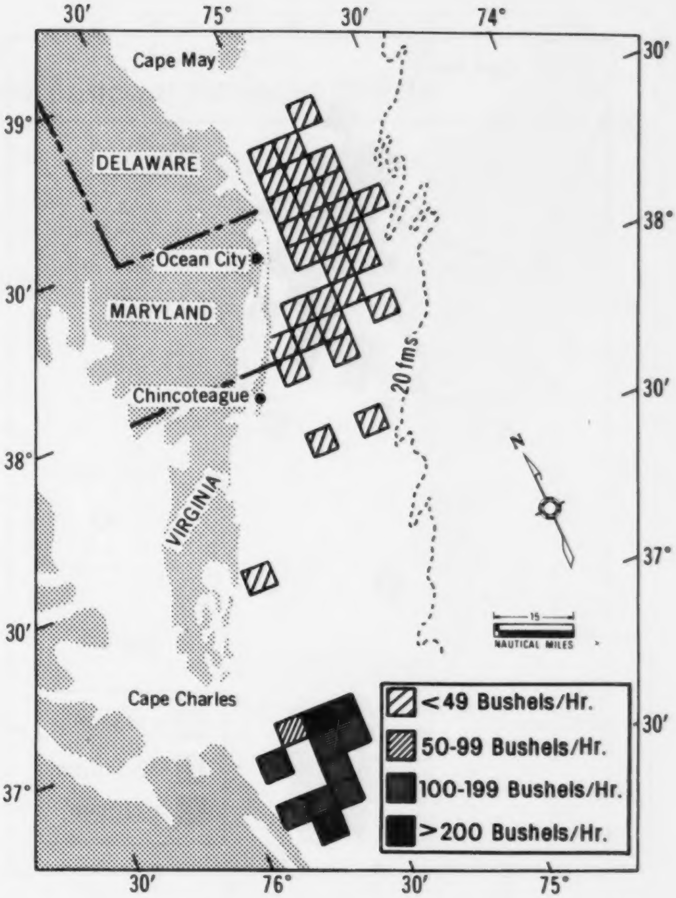

Figure 3.—Catch per hour within the area fished by the Maryland and Virginia fleet in 1973 (based on 292 interviews).

STATUS AND TRENDS OF THE FISHERY

An increase in surf clam landings at several ports indicated a general increase in effort this year on the resource in response to increased demand. Table 2 shows the landings of major commercial clams from the coastal area of Maine through Virginia for the period 1971-73. Landings of soft clams, hard clams, and ocean quahogs totaled 30.4 million pounds in 1971, but decreased by 9.2 million pounds in 1972. All three fisheries recorded lower landings in 1972—soft clams were down 4.2 million pounds, hard clams were down 4.4 million pounds, and ocean quahogs were down 0.7 million pounds. Landings for these three resources remained at about

Table 2.—Landings of major commercial clams in the northeast Atlantic (1971-73).

	Million lb				
Year	Surf clam[1]	Hard clam	Soft clam	Ocean quahog	Total
1971	40.1	15.9	12.4	2.0	70.4
1972	63.3	11.5	8.2	1.4	84.4
1973	82.3	12.0	8.0	1.3	103.6

[1]Landings of bait included.

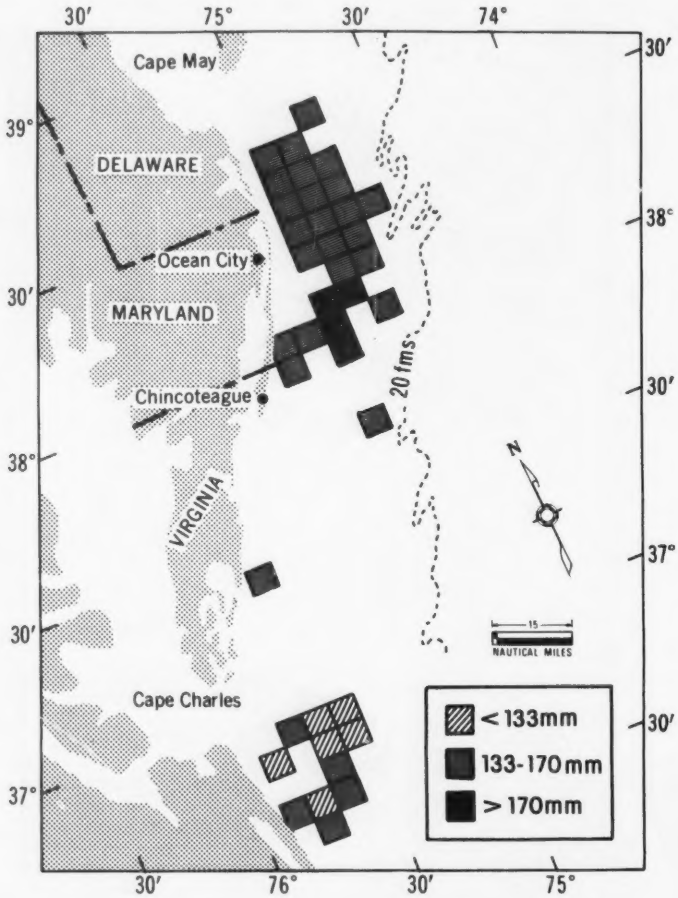

Figure 4.—Mean shell length of surf clams and area of catch by the Maryland and Virginia fleet in 1973 (based on 292 interviews).

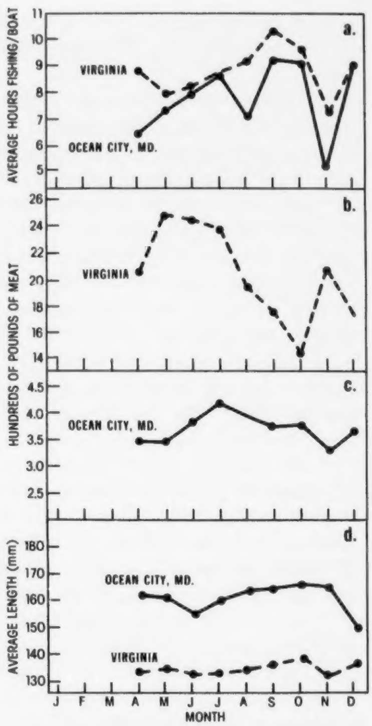

Figure 5.—Monthly averages of trip effort (a), catch per hour (b and c), and shell lengths of surf clams (d) at Maryland and Virginia ports—1973 (based on 292 interviews).

the same level in 1973. Thus, increased landings of surf clams indicate, in part, a response to lower landings of the other principal clam resources since 1971. However, total landings of all clams have increased since 1971 indicating that demand for clam products is healthy. The doubling of surf clam landings (40.1 to 82.3 million pounds) has more than compensated for decreases in landings of other clam resources.

The greatest landings of surf clams were made from beds off the Virginia coast and amounted to more than half of the United States total. Although about one-fifth of the total surf clam fleet of 98 vessels used Virginia ports as fairly permanent bases, almost as many more vessels fished the Virginia beds as port migrants. The clams were harvested at an average rate of 2,040 pounds per hour which, although only slightly higher than reported in 1972, is higher than has ever been reported for this fishery. The clams came from beds concentrated in a relatively small area compared with the beds fished by the Maryland fleet. These beds were in many of the same fishing areas reported for 1972.

The decrease in landings at Cape May-Wildwood and Lewes can be explained, even in the absence of interview data. The decrease corresponds to a reduction in landing from offshore beds of 15.2 million pounds in 1972 to 9.4 million pounds in 1973. Inshore landings (0-3 miles) were up from 8.2 million pounds in 1972 to 9.7 million pounds in 1973 (Wheeland, 1973; Thompson, 1974); not enough to compensate for offshore losses. Some offshore vessels from these ports migrated to Virginia waters.

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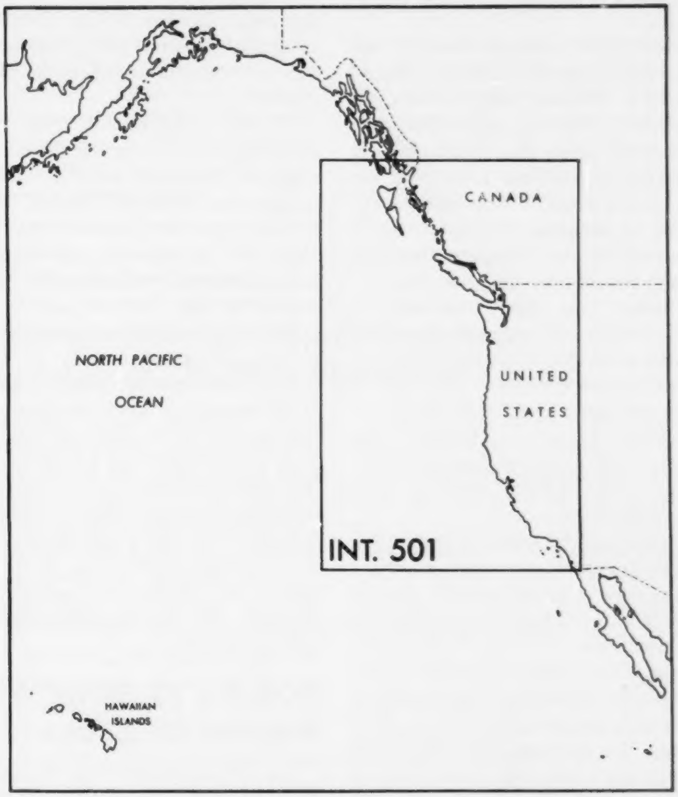
NOAA Issues First of Five International Nautical Charts



Northeast Pacific Ocean area covered by new NOAA chart.

Publication of the first of five international charts to be produced by the National Oceanic and Atmospheric Administration has been announced by the Department of Commerce. The chart, prepared by NOAA's National Ocean Survey (NOS), covers a vast area of the Pacific Ocean off the west coast of the United States and Canada (see map), and is issued by NOS as part of a multination program sponsored by the Monaco-based International Hydrographic Organization (IHO).

The IHO program is designed to provide a standard series of charts for the entire world which can be used by all nations. Each member nation is authorized to reprint charts in its own language, but employing the same form of navigational information, such as depth curves, sounding spacing, aids to navigation, and nautical symbols. Nations which have agreed to produce and issue international charts are Canada, West Germany, United Kingdom, France, Brazil, Argentina, Chile, Italy, Netherlands, Japan, India, New Zealand, Australia, and possibly South Africa.

Published by the agency's office of Marine Surveys and Maps, headed by Robert C. Munson, the new chart is 1:3,500,000 scale, and the survey's first metric nautical chart. The U.S. Defense Mapping Agency, Hydrographic Center, and foreign nations have previously issued metric international nautical charts.

The chart was compiled in accordance with IHO specifications and shows elevations and depth in metric units. Loran-A lines of position for electronic navigation are shown in addition to the usual nautical chart information.

The chart, International Chart INT. 501 (National Ocean Survey Chart 501) is priced at $3.25, and may be obtained from the NOS Distribution Division (C44), Riverdale, MD 20840.

SEWAGE SLUDGE TRACED OFF NEW YORK STATE

Using an underwater acoustic system originally designed for detecting schools of fish, National Oceanic and Atmospheric Administration scientists began studying the feasibility of tracking sewage sludge in the waters off New York and New Jersey in September. The research was concentrated within the New York Bight—a 15,000-square mile area extending from Cape May, N.J., to Montauk Point, N.Y., and seaward to the edge of the continental shelf approximately 100 miles offshore.

Ringed by densely populated communities, the New York Bight receives sewage sludge, the byproduct of waste water treatment, at a rate of about 150 million cubic feet a year in what is America's largest ocean dumping operation. But where this sludge finally ends up, and its environmental effect in the Bight, are unsolved problems. With the aid of ship-mounted acoustic sounders the NOAA oceanographers hope to find some of the answers.

The experiment is being carried out by the Commerce Department agency's scientists as part of NOAA's Marine Ecosystems Analysis New York Bight Project. "Locating suspended particles in the ocean by the acoustic sounding technique has potential application for monitoring many kinds of dredging or dumping operation in the coastal zone and for deep ocean mining activities," says John R. Proni, an oceanographer with NOAA's Ocean Remote Sensing Laboratory in Miami.

"Specifically the technique should be useful for studying turbid water plumes emanating from rivers, for analyzing waters used for dumping waste products in estuaries and harbors, and for studying materials brought up by suction pipe from the ocean floor to the near

surface during mining operations." The remote sensing method also has been used recently for detecting internal waves and temperature fluctuations in the sea.

Proni and his colleagues were to operate two acoustic sounders aboard NOAA's 180-foot ship *George B. Kelez* as it followed a sludge-filled New York City barge five miles or more southeast of Ambrose Light near the New Jersey coast. Following the completion of dumping, the vessel was to crisscross the area, mapping what happens to the dumped material over several hours' time. Some materials will likely remain suspended in the water column while others will either rain out on the bottom or float to the surface. From the picture painted by the acoustic system, Proni can selectively take samples of these various fractions to determine their physical characteristics and composition.

A National Aeronautics and Space Administration U-2 aircraft, equipped with a multi-spectral scanner, was to make at least one flight overhead during the experiment as a "sky-truth" comparison. The Landsat-II satellite is also scheduled to record the barge and ship's position during one of its overpasses of the area. The Environmental Protection Agency and Coast Guard are acting as observers during the experiment.

While the project is underway, normal sludge dumping operations in the Bight were to cease for two days. During this time the City of New York sewage sludge dumping vessels and additional barges operated by Pollution Control International, General Marine Transport Corporation, and Modern Transport Corporation were to make special dumps of sewage sludge to provide "targets" for the NOAA experiments.

"Acoustic sounders are devices using different sound frequencies to paint a picture of what is going on beneath the water's surface," Proni says. "By sending out a rapid-fire stream of sound signals at a set interval, we can identify the location of various suspended particles in the water by the sound signals bounced off the material and returned to the sounder's receiver on board the ship."

Data returned by this method should enable sedimentologists to measure suspended sediments and help geologists better understand erosion processes in the Bight. Environmental managers should be able to use the information for determining where contaminated material goes and how it moves horizontally beneath the Bight's surface.

During the experiment, Proni and his colleagues were to operate the acoustic sounders simultaneously at different frequencies. While the "brains" of the echo sounders are located on board the ship, the instrument's transducers—sound-emitting devices—are towed behind the ship via short cables.

The larger of the two torpedo-shaped transducers emits sounds at 20,000 Hertz (cycles per second), the smaller at 200,000 Hertz. Both instruments are powered by 1-2 kilowatts of energy for each sound pulse and function above the range of human hearing as they track the barge's dumped cargo. A cable attached to each sound transducer carries the returning signals back to the ship where the sounds are recorded on magnetic tape for later computer readout and analysis.

NOAA's 25 Ships Will Monitor Oil Slicks

The 25-ship fleet of the Commerce Department's National Oceanic and Atmospheric Administration has been directed to monitor slicks and other oil pollutants as part of a United Nations' program called Integrated Global Ocean Station System (IGOSS). NOAA's participation in IGOSS is part of a worldwide pilot program designed to pave the way for the monitoring of marine pollutants on a global scale. The 2-year program is organized by the UN's Intergovernmental Oceanographic Commission and the World Meteorological Organization.

The U.S. coordinator for IGOSS is Robert Junghans of NOAA's Office of Environmental Monitoring and Prediction. He is Deputy Director of its Oceanographic Services Office and was a former member of the Secretariat of the Intergovernmental Oceanographic Commission.

The monitoring activities of the NOAA ships will cover areas in the Atlantic Ocean, Gulf of Mexico, Pacific Ocean, and the Bering Sea, and will include both inshore and offshore water. In addition to monitoring oil slicks, vessels with appropriate equipment will collect samples of oil tar balls. Other ships will gather, for laboratory analysis, samples of dissolved petroleum hydrocarbons from the upper 3 feet of the ocean. The information gathered by U.S. participants is being forwarded to NOAA's National Oceanographic Data Center. The data will be archived and exchanged among nations so periodic assessments can be made of the state and degree of ocean contamination.

U.S. participants in the IGOSS program also include the Coast Guard, Defense Department, academic institutions, and cooperating ships of the commercial fleet, which are recruited through the Port Meteorological Officer element of NOAA's National Weather Service.

Junghans said the Office of Technology of the U.S. Senate Commerce Committee soon will publish an analysis of marine pollution and safety measures in a report entitled "Oil Transportation by Tankers." That report shows, he said, that about one million tons of oil a year are dumped into the ocean in standard tanker operations such as tank cleaning, deballasting, etc. Additionally, about 200,000 tons of oil are spilled yearly as a result of tanker casualties, and an added 250,000 tons of oil pollution annually is associated with tanker dry-docking activities, he said.

The UN program recognizes that marine pollution must be dealt with on a global scale as a threat to fisheries, recreation sites, environmental values, and human health. Little is known about these myriad effects. Meanwhile, the problems are intensifying because populations are expanding, the oceans are being increasingly used for transporting fuel and minerals, seabed oil and gas drilling are growing, and seabed mining is just over the horizon.

NOAA ships participating in the program include the Norfolk-based vessels *Ferrel*, *George B. Kelez*, *Mt. Mitchell*, *Pierce*, *Rude*, *Heck*, and *Whiting*; *Albatross IV* of Woods Hole, Mass.; *George M. Bowers* and *Researcher* of Miami, Fla.; *Delaware II* of Sandy Hook, N.J.; *Oregon II* of Pascagoula, Miss.; *Townsend Cromwell* of Honolulu; *David Starr Jordon* of San Diego,

Calif.; *Murre II* of Auke Bay, Alaska; *Oregon* of Kodiak, Alaska; and *John N. Cobb, Davidson, Fairweather, Miller Freeman, McArthur, Oceanographer, Rainier, Surveyor*, and *Discoverer*, all Seattle-based.

NOAA Creates Office of Marine Minerals

An Office of Marine Minerals has been established in the Department of Commerce's National Oceanic and Atmospheric Administration, Secretary of Commerce Rogers C.B. Morton has announced. "The development of marine mineral resources of the deep ocean and of the continental shelf will become increasingly important to the economic well being of the United States," Scretary Morton said. "This must be done in an environmentally sound manner and in a way that permits U.S. industry to move into this activity in an efficient way. To do this, NOAA is embarking on an expanded program which will bring together the broad capabilities of NOAA."

The new office reports to the Associate Administrator for Marine Resources. It serves as a focal point for NOAA's new and expanding programs in marine minerals. It has planning, coordinating, and certain operational responsibilities. It will also facilitate liaison with other Federal agencies. Amor L. Lane was designated Acting Director of the Office, which began functioning immediately. Lane was head of the Non-Living Resources activities in NOAA's Office of the Associate Administrator for Marine Resources. He continues to serve as Executive Secretary of Commerce's Marine Petroleum and Minerals Advisory Committee.

The major new effort to be launched is the Deep Ocean Mining Environmental Study (DOMES) to be conducted in FY 1976 for which $3 million was included in NOAA's predicted budget. This study will assess the pre-mining environment of selected manganese nodule mining areas in order to be able to predict the potential environmental consequences of deep ocean mining. Manganese nodules—rich in manganese, nickel, copper, and cobalt—cover large areas of the ocean floor.

In addition, in FY 1976 mineral resource-related programs will be sponsored by NOAA's Office of Sea Grant at a level of approximately $750,000 (with matching funds included).

NOAA was assigned marine mining responsibilities through the transfer of the Bureau of Mines' Marine Minerals Technology Center (MMTC) from Interior to NOAA when NOAA was established in 1970. MMTC's functions were transferred in 1973 to NOAA's Pacific Marine Environmental Laboratories in Seattle, Wash.

Prior to working with NOAA, Lane was Director of Planning for Marine Activities for AMF, Inc., Executive Secretary of the Governor of Delaware's Task Force on Marine and Coastal Affairs, staff member of the Stratton Commission on Marine Science, Engineering and Resources, and Chairman of the Executive Committee of the NSIA Ocean Science and Technology Advisory Committee (OSTAC).

Foreign Fishery Developments

Canadian Officials Reject Unilateral Extension of 200-Mile Economic Zone

Canadian Prime Minister Pierre Trudeau held a press conference on 7 August and spoke against a Canadian unilateral extension to a 200-mile Economic Zone, according to the Office of International Fisheries, National Marine Fisheries Service, NOAA. Trudeau said: "Canadians at large should realize that we have very large stakes indeed in the Law of the Sea Conference and we would be fools to give up those stakes by an action that would be a purely temporary, paper success . . . We would have to go to war to impose our unilateral action if we couldn't negotiate it in an acceptable way." On another subject, Trudeau also reiterated his government's commitment to the idea of free trade and to the Economic Council of Canada's recommendation that the country lower its trade barriers.

Former Newfoundland Premier Joseph R. (Joey) Smallwood began a cross-country speaking tour to support an extension of the Canadian fishing zone to 200 miles. Smallwood claimed his mission was nonpartisan, but he had recently founded the Liberal Reform Party, and he may find political success in the issue of extended jurisdiction.

The Canadian press gave good coverage to Secretary of State Kissinger's speech against U.S. unilateral extension. The lead editorial of the 13 August *Montreal Star* strongly supported the Secretary's position: "In more ways than one, Henry Kissinger's address this week to the American Bar Association underlined the wisdom of the Canadian Government's refusal to impose unilaterally a national economic zone 200 miles out to sea."

Iceland Extends Fishery Limits to 200 Miles

Icelandic fishery limits were extended to 200 miles on 15 July 1975 and the new law entered into force on 15 October, according to the U.S. Embassy, Reykjavik. Iceland extended its jurisdiction to 50 miles in 1972, and hoped that the latest extension will further protect its major resource (75 percent of Iceland's foreign exchange comes from the fishery exports). Since the country's imports are equal to about 50 percent of its Gross National Product (GNP), the exchange it receives from fish exports is essential to the economy. The Government of Iceland claimed that the country's fish stocks could no longer support fishing by foreign fleets, and that the Icelandic fishing fleet is capable of fully utilizing the resource. Iceland therefore extended its jurisdiction.

The new law specifies the precise limits of the 200-mile boundary, and allows for the areas between Iceland and Greenland and the Faroe Islands, when those coasts are separated by less than 400 miles, to be demarcated by an equidistant boundary. Further specific regulations and restrictions to both foreign and Icelandic vessels in certain

areas and at specific dates are listed in the new regulations.

The Government of Iceland hoped that extended jurisdiction would help the fishing industry, which continued to be depressed. Having greatly overextended itself, the industry hoped to improve its position by early 1976. The outlook for 1975, however, was unpromising. From January through April, fishery catches declined except for demersal catches by stern trawlers. The total catch was only 1.4 percent higher than during the same period in 1974, and rising fuel costs have dramatically affected profits. In addition, a strike by the stern trawler workers which ended 13 June also affected the industry. Tables 1, 2, 3, and 4 show total catch from 1972-1974, and list exports by destination and species. Further statistics for the Icelandic fishing industry may be obtained by mailing a pre-addressed envelope to R. V. Arnaudo, International Fisheries Analysis Division, NMFS, NOAA, Washington, DC 20235.

Table 1.—Iceland's fish catch[1], 1972-74, in thousands of metric tons.

	Catch		
Species	1972	1973	1974
Ling	7	4	4
Cod	229	236	239
Haddock	30	35	33
Saithe	60	57	65
Ocean perch	33	29	37
Plaice	5	4	4
Greenland halibut	6	3	4
Other demersal	25	21	27
Total demersal	395	389	413
Herring	41	43	40
Capelin	277	442	465
Lobster	4	3	2
Shrimp	5	7	6
Scallop	7	5	3
Other	6	12	9
Total	735	901	938

[1]Source: Statistical Bureau of Iceland.

Table 2.—Icelandic exports of fish and shellfish[1], 1973-1974 (whale products included).

	1973			1974		
Product	Metric tons	M. Kr.	[2]$1,000	Metric tons	M. Kr.	[2]$1,000
Salt and dried fish	37,434	3,349	40,060	41,408	6,695	66,950
Fresh herring	42,787	1,027	12,284	38,984	1,082	10,820
Fresh fish, other	17,925	572	6,842	17,133	724	7,240
Frozen fillets	63,698	7,013	83,888	59,996	8,141	81,410
Frozen fish, other	24,336	900	10,766	24,812	1,458	14,580
Frozen lobster	665	382	4,570	672	469	4,690
Frozen shrimp	1,421	557	6,663	1,135	542	5,420
Frozen scallops	505	177	2,117	357	115	1,150
Canned fish	1,751	294	3,516	1,621	491	4,910
Cod meal	26,316	1,110	13,277	22,613	877	8,770
Capelin meal	63,467	2,376	28,433	58,237	2,348	23,480
Fish meal, other	4,718	217	2,596	2,078	66	660
Fish oils	23,730	467	5,586	28,567	1,078	10,780
Other	17,026	749	8,959	7,350	501	5,010
Total	325,779	19,190	229,557	304,963	24,587	245,870

[1]Source: Statistical Bureau and Embassy estimates.
[2]Rates of exchange: 1973 $1 = 83.60 Ikr. (this figure varied; e.g., in June $1 = 91 Ikr.); 1974 $1 = 100 Ikr. (avg. annual rate).

Table 3.—Icelandic exports of fish and shellfish to the United States, 1973-1974.

	1973		1974	
Product	Metric tons	$1,000	Metric tons	$1,000
Frozen fillets, blocks	51,161	73,409	42,876	62,700
Frozen lobster, nephrops	356	2,763	499	3,870
Frozen scallops	505	2,105	356	1,150
Other	1,851	1,770	2,593	3,039
Total	53,873	80,047	46,324	70,759

Table 4.—Icelandic exports of fish and shellfish[1] by major destination, 1973-74.

	1973				1974			
Destination	1,000 kg	%	$1,000	%	1,000 kg	%	$1,000	%
West Germany	32,780	10	17,057	8	29,831	9	13,340	5
EC (6 other)	31,030	10	19,509	8	14,157	5	13,770	6
Subtotal	63,810	20	36,566	16	43,988	14	27,110	11
United Kingdom	37,179	11	20,335	9	21,371	7	11,240	5
Denmark	59,699	18	38,696	16	48,998	16	15,850	6
EC[2] (9)	160,688	49	95,597	41	114,357	37	54,200	22
United States	53,873	17	80,047	35	46,324	15	70,579	29
USSR	12,144	4	7,846	3	26,678	9	21,160	9
Other	99,174	30	46,016	21	117,605	39	99,761	40
Total	325,879	100	229,506	100	304,964	100	245,700	100

[1]Source: Statistical Bureau and Embassy estimates.
[2]Includes exports to Ireland.

Venezuela Offers to Purchase Fishing Fleet

The Venezuelan Agriculture and Livestock Ministry has initiated negotiations with the Venezuelan Federation of Trawler Fishermen (AVINCASA) for the purchase of their vessels, cold storage, and related facilities, according to the U.S. Embassy in Caracas. The Government reportedly offered the owners between 400 and 500 million Bolivares (US$93-116 million). The action was ordered by President Carlos Andres Perez at the request of the vessel owners. Over 400 trawlers had been tied up to protest a Government conservation measure which prohibited trawling within 6 miles of the coast. The Venezuelan press speculated that the owner's lockout was a bluff and the Government's offer to buy them out has called their bluff.

Negotiations between the Venezuelan Government and the representatives of AVINCASA continued, while the trawler owners resumed operations, scrupulously observing the 6-mile regulation by not engaging in fishery operations between the Venezuelan coast and the 6-mile line. Informed observers asserted that issues other than outright purchase were discussed and speculated that one possible solution might be Government credits to the fishing industry to enable the trawler owners to modernize their vessels. This would make it possible for them to operate profitably farther from the coast than before. It was estimated that such a scheme required an investment of between US$30,000 and US$40,000 per craft.

EC Temporarily Suspends Some Fish Tariffs

Due to low production and high prices the EC (European Economic Community) Council temporarily suspended the autonomous Common Customs Tariff duties on several fishery products on 19 June 1975. The new rates are listed in Tables 1, 2, and 3. Table 1 suspensions are applicable from 1 July 1975 to 14 February 1976 and from 16 June 1976 to 30 June 1976. Suspensions listed in Table 2 are applicable from 1 July 1975 to 30 June 1976 and in Table 3 will be applicable from 1 September 1975 to 31 March 1976.

For additional information, please contact Fred Olson, Special Assistant for Economics, Office of International Fisheries, NMFS, NOAA, Commerce, Washington, DC 20235; Telephone 202-634-7307.

Table 1.—Suspensions from 1 July 1975 to 14 February 1976.

CCT heading No	Description of goods	Rate (%) of autonomous duty
ex 03.01 B I m) 2	Mackerel, fresh, chilled or frozen, whole, headless, or in pieces, intended for the processing industry[1].	15

[1]This suspension is subject to conditions to be determined by the competent authorities.

Table 2.—Suspensions from 1 July 1975 to 30 June 1976.

CCT heading No	Description of goods	Rate (%) of autonomous duty
03.01 A I b)	Salmon, fresh (live or dead), chilled or frozen.	0
ex 03.01 B I e)	Piked dogfish (*Squalus acanthias*), fresh, chilled or frozen, whole, headless, or in pieces.	0
ex 03.01 B I g)	Black halibut (*Hippoglossus reinhardtius*, fresh, chilled or frozen, whole, headless, or in pieces.	0
ex 03.01 B I q)	*Sardinops sagax*, *sardinops ocellata* (pilchards), fresh, chilled or frozen, whole, headless, or in pieces, intended for the processing industry[1].	8
ex 03.01 B I q)	Sturgeons, fresh, chilled, or frozen, whole, headless, or in pieces, intended for the processing industry[1].	8
ex 03.01 C	Roes, fresh, chilled, or frozen.	0
ex 03.02 A I c)	Anchovies (*Engraulis* spp.) salted or in brine, whole, headless, or in pieces, in barrels or other containers of a net capacity of 10 kg or more.	0
03.02 A I e)	Salmon, salted or in brine, whole, headless, or in pieces.	4
ex 03.02 A I f)	Sprats, salted or in brine, whole, headless, or in pieces.	0
ex 03.02 A I f)	Saithe (*Gadus virens*), salted or in brine, whole, headless, or in pieces.	7
ex 03.02 A II d)	Fillets of saithe (*Gadus virens*), salted or in brine.	7
ex 03.02 C	Fish roe, salted or in brine.	0
ex 03.03 A I	Tails of crawfish, chilled or frozen, shelled or not.	10
ex 03.03 B I b)	Oysters, fresh (living), weighing no more than 12 g each.	0
ex 03.03 B I b)	Oysters, fresh (living), of the '*Crassostrea gigas*' variety, weighing more than 100 g each.	0
ex 16.04 C II	Spiced and salted herrings, packed in barrels, intended for the processing industry[1].	12
ex 16.05 A	Crabs of the 'King,' 'Hanasaki,' 'Kegani,' and 'Queen' varieties, simply boiled in water and shelled, whether or not frozen, in packings of a net capacity of 2 kg or more, intended for the processing industry[1].	0
ex 16.05 B	Shrimps and prawns other than those of the '*Crangon*' variety, boiled in water and shelled, whether or not frozen, intended for the industrial manufacturers of products falling within heading No 16.05[1].	10
23.07 A	Fish or marine mammal solubles.	2

[1]This suspension is subject to conditions to be determined by the competent authorities.

Table 3.—Suspensions from 1 September 1975 to 31 March 1976.

CCT heading No	Description of goods	Rate (%) of autonomous duty
ex 03.01 B I d)	Sardines (*Clupea pilchardus* Walbaum), fresh, chilled or frozen, whole, of a length of 20 cm or more.	0

Panama Expects 1975 Shrimp Catch to Increase

Panamanian officials predicted increased shrimp landings in their country this year despite a low catch during the first of the year, according to the U.S. Embassy, Panama. The February-March ban on shrimping during the crustacean's most rapid growth period was expected to result in a total 1975 catch estimated at 600 metric tons larger than the 1974 take of 5,300 tons. Most of the increased landings were white shrimp, which in 1974 amounted to 1,300 tons, or about 25 percent of the total shrimp catch.

Local inventories averaged about 175 tons, or half of the monthly exports. Panama exports shrimp to the United States only and the volume of trade in 1975 may approach the 1970 level of 5,000 tons, up from 4,400 tons in 1974.

Iran and Korea Sign Fisheries Agreement

The Director General of the Office of Fisheries of the Republic of Korea (ROK), Yong Soon Kang, and the Chairman of the Board and Managing Director of the Persian Gulf Fisheries Company of Iran, Esmail Riahi, held a series of meetings in Tehran, Iran 26-28 May 1975 to discuss the implementation of a Memorandum of Understanding which was signed in Seoul on 22 January 1975, according to the Office of International Fisheries, National Marine Fisheries Service, NOAA. As a result of the meetings, another memorandum was signed on 28 May 1975 in which Korea and Iran pledged further cooperation in fisheries and planned specific technical training programs.

Both governments noted the progress of the joint fishing venture between the Sail Fisheries Company and the Persian Gulf Fisheries Company, under which ROK has agreed to send two stern trawlers and two tuna longliners to Iranian waters for one year. In addition, Korea plans to accept 10 Iranian students to study fishery subjects (oceanology, marine biology, ichthyology, etc.) at the ROK National Fisheries and Development Agency, or at the Pusan Fisheries College. The Republic of Korea has also agreed to train five Iranian captains and five engineers each

year for a period of 5 years. In both cases, expenses will be paid by Iran. Finally, Korea will send an unspecified number of fishery managers, technicians, engineers, and experts in ship repair and maintenance, marketing, fish processing, etc. to assist in the development of fisheries and to train personnel in Iran at Iran's expense. Both parties to the Memorandum also agreed to continue discussions on the use of port facilities and on trade promotion activities.

U.S. Officials Seize Cuban Shrimp Trawler

A Cuban shrimp trawler was seized 2 August 1975 by a U.S. Coast Guard/National Marine Fisheries Service (NMFS) enforcement patrol after she was observed with her trawl in the water within the U.S. Contiguous Fishing Zone (CFZ) off St. Joseph's Island, Tex., according to the Office of International Fisheries, NMFS. The vessel, the *E-82HB*, a 76-foot, E-class, Spanish-built trawler, was seized and towed to Corpus Christi, Tex. by the Coast Guard cutter *Point Baker*.

The Cubans did not resist arrest; however, under orders from Havana, the crew refused to haul in their outriggers and these had to be brought aboard by U.S. officials after the vessel anchored at Corpus Christi.

The Cuban master pleaded not guilty to the charges and waived his right to a jury trial. The case was transferred from Corpus Christi to the U.S. District Court in Houston where the master was found guilty. He was sentenced as follows: "Master may not enter the United States and may not engage in commercial fishing for one year." In the civil suit against the *E-82HB*, the vessel was found to have violated the CFZ and has been ordered forfeited to the United States. Arrangements were made for a Cuban vessel to repatriate the master and crew.

The last Coast Guard seizure of a Cuban fishing vessel, the *E-39SF*, took place near Galveston, Tex. on 28 July 1974. The master of that vessel was convicted of fishing in the United States' CFZ, put on probation, and fined US$25,000. Additionally, in the civil suit against the *E-39SF*, the vessel was forfeited.

Indian Ocean Fisheries Commission Meets

The fourth session of the Indian Ocean Fisheries Commission (IOFC) opened in Mombasa, Kenya on 21 July 1975 with more than 60 top fishery officials from 15 member nations, observers from 2 FAO member nations, and observers from 5 international organizations attending, according to the U.S. Regional Fisheries Attache for Africa. Mathews Ogutu, Kenya's Minister of Tourism and Wildlife, noted a theme which was echoed by many of the delegates from the developing countries, saying, "I should like to emphasize that the main aim of technical assistance programs should be the transfer of technical know-how and expertise from developed nations to the developing countries."

A reply to the minister's speech was made by the Assistant Director General (Fisheries) of FAO, F.E. Popper, who noted the need for international cooperation in the Indian Ocean, especially in view of expected changes in fishery regimes following future law of the sea talks.

The sessions were chaired by Norbert Odero, Kenya's Director of Fisheries. The first item discussed was statistical reporting. It was agreed that catch data, starting in 1975-76, would be broken down by subareas and divisions in accordance with a standardized Indian Ocean species list. Training programs for statisticians were announced.

Present and future FAO coastal aquaculture programs were examined and endorsed. The establishment of regional coastal fish culture centers, subregional training centers, as well as research into the viability of coastal aquaculture, was proposed.

The international Indian Ocean fishery survey/development program budget has increased from U.S. $2 million in 1973 to US$4.2 million in 1975. The work of the program is changing from basic studies to survey and development. Major resource surveys are underway in the Arabian Sea, off the East African coast, in the Indonesia-Australia area, and in the Bay of Bengal. Sweden (SIDA) is now studying possible participation in the program in the Bay of Bengal, and a decision is expected in 3 months. A research cruise report in Kenya-Somalia waters and in the Arabian Sea by the Norwegian (UNDP/NORAD) research vessel *Dr. Fridtjof Nansen* was discussed. The report pointed out the need to translate scientific data into increasing catches. East African delegates welcomed a report on an FAO/USSR research cruise between Somalia and Madagascar planned from November 1975 to November 1976 by the research vessel *Prof. Mesiatsev* (3,000 GRT) with a crew of 65 and 23 scientists. The vessel will be based in Mombasa. In addition to FAO scientists, 10 local scientists will participate on one of four 75-day cruises. The Commission also examined the need for additional training courses which would follow fishery surveys, and the need to shorten the time lag between both was stressed.

In the session on the state of fishery stocks and management, a Tuna Management Committee report was adopted. Coastal shrimp stocks were reported heavily fished now, but deep-water shrimp stocks had good potential. Management measures are of great importance. An ad hoc group was established to meet at the end of 1975 to examine this resource and report its findings to IOFC. Possible development of an oil sardine fishery was examined, and no management problems were expected with it.

The importance of small-scale fisheries was strongly stressed by many participating countries which indicated a need for multi-aspect development programs from research to fishing, landings, ports, processing, cold storage, transportation, marketing, and consumption. The role of national governments in training fishermen, establishing cooperatives, etc., was stressed. Developing nations agreed on the need to translate scientific research into increased catches.

A need to improve cooperation with other fisheries bodies was also noted. Assistance in statistical work and training programs from the International Commission for the Conservation of Atlantic Tunas and the Inter-American Tropical Tuna Commission was acknowledged, and the possibility of establishing an international fisheries body for the Western Pacific was discussed. The need to protect coastal

waters from oil pollution was examined and the Secretariat was requested to investigate methods of solving this problem in the Western Indian Ocean. The Committee on Management of Persian Gulf Shrimp was abolished and its activities taken over by the Committee for Development and Management of Fishery Resources of the Gulf.

The delegates elected Kenya's Norbert Odero Chairman of the forthcoming 5th Session of the IOFC. P.C. George (India) was elected the first vice-chairman. Elected to the Executive Committee of the IOFC were the United States, Australia, Indonesia, Japan, Mauritius, Qatar (not present), Sweden, and Tanzania.

Poor Shrimp Season Felt in Nicaragua

Nicaragua's shrimp catch for the first 3 months of 1975 was down significantly from 1974, and the overall consensus within the shrimp industry was that the total 1975 catch will be well below that of last year's, according to the U.S. Embassy, Managua, Nicaragua.

Nigaraguan shrimp catch (× 1,000 lb).

Month	1974	1975
January	973.1	534.5
February	580.7	412.5
March	537.8	448.5

By mid-June 1975, shrimp landings were well below the corresponding levels of 1974, according to shrimp industry sources. The three shrimp companies fishing in the Pacific reported a slight improvement in the last 2 weeks of June, but it was too early to tell if this trend would last or whether this was only a temporary improvement in what had so far been a disastrous season. Changes in marine currents, the pollution of bays and inlets with insecticides, a decrease in plankton caused by low rainfall along the coast, and overfishing are given as reasons for the year's reduced catch. No scientific data, however were available to support any one of these theories. Nicaragua exports from 80 to 85 percent of its shrimp catch, all of which goes to the United States. The shrimp fishing and processing companies are entirely oriented to the U.S. market.

The Nicaraguan shrimp industry finds itself in a very bad financial state. Prices have been decreasing since 1973, particularly for small and medium shrimp. About 70 percent of Nicaragua's shrimp catch comes from the Caribbean, where average shrimp size is smaller. Costs have increased sharply. Productivity has been continually declining and a further decline

Productivity of Nicaraguan fishing vessels (in pounds of shrimp per hour of fishing).

Year	Atlantic coast	Pacific coast
1970-71	33.5	15.1
1971-72	28.3	11.2
1972-73	25.2	10.3
1973-74	19.1	n.a.

was reported for the 1975 season. Discussions were underway to limit the number of vessels operating in Nicaraguan waters.[1] Their number has been steadily increasing over the past 10

Number of shrimp vessels in Nicaraguan waters.

Year	Atlantic coast	Pacific coast
1965	38	12
1975	115	53

years, but a number of independent fishing vessels will probably be sold and/or withdrawn from Nicaraguan fishing waters if the catch remains poor for the rest of the year.

[1]On 5 April 1975, Executive Decree 1-L established a 200-nautical mile exclusive fisheries zone.

ICSEAF Slates Check of Trawler Net Mesh Sizes

The International Commission for Southeast Atlantic Fisheries (ICSEAF), an organization formed in 1974 to control and protect bottomfish stocks in the Southeast Atlantic, has announced that it will begin checking the mesh size of nets used by trawlers, according to a report in *The Argus*, Cape Town, South Africa. ICSEAF member countries—Belgium, Bulgaria, Cuba, East Germany, France, Japan, Poland, Portugal, South Africa, and the USSR—agreed upon a minimum mesh size of 110 mm in 1974 and the Commission will start inspecting vessels operating outside territorial waters.

Each ICSEAF signatory will provide vessels and inspectors. The inspection vessels will fly a special identification pennant, and the inspectors will carry identification cards which will allow them to inspect the nets of vessels of any of the other ICSEAF member countries. Inspections cannot take place, however, while a vessel is hauling her nets, or when an inspection would interfere with fishing operations.

Ecuador Records Big 1975 Shrimp Catches

Ecuadorian shrimp landings in the first quarter of 1975 (January-April) were 10-20 percent higher than in 1974, the U.S. Consulate in Guayaquil reports. Beginning in May, landings skyrocketed as the shrimp fleet brought in loads as high as 3,000-4,000 pounds per vessel compared with only 1,500 pounds per vessel the year before. The excellent catch is attributed, at least in part, to the beneficial effects of abundant winter (December-April) rains.

Almost all of Ecuador's shrimp exports have gone in recent years to the United States, and it is believed that an estimated 95 percent would go there in 1975. And although a new Fishing Law has required local producers to sell 20 percent of all shrimp landings on domestic markets, some company owners predicted that 1975 exports would still be almost twice as large as the 1974 exports.

Ecuadorian consumers reportedly will be served early and late in the year when smaller shrimp are harvested, while foreign markets will receive most of the landings during peak production periods in mid-year when the best and largest shrimp are caught. Ecuador's producers, however, are still dissatisfied with the 20 percent quota because export prices are higher. Nevertheless landings this year are expected to be so good that bountiful exports are practically assured. To process all the catch, for example, large plants are currently working overtime and occasionally on weekends.

In fact, Ecuador's shrimp exports in 1975 may be 60 percent higher than they were in 1974, when, due to light rainfall and low prices abroad, exports were at a disappointing 5.9 million pounds. Some company owners confidently predicted that their exports would almost double those in 1974. These predictions may be exaggerated hopes of businessmen who

lost money last year. However, the high catches in the key months of May and June indicated a bright outlook for the remainder of the year. A reasonably conservative guess was that Ecuador would export at least 8 million pounds of shrimp in 1975 and possibly as much as 10 million pounds, thereby exceeding the record 9 million pounds of 1969, as shown in the table below.

Ecuadorian shrimp exports in millions of pounds, 1969-75.

Year	Exports
1969 (record year)	9.0
1973	8.2
1974 (unofficial)	5.9
1975 (projected)	8-10

Hatcheries and pond growers have also entered into the Ecuadorean shrimp picture for the first time in numbers. They were expected to produce 250,000 pounds in 1975. The impact of these hatcheries on total production will remain small for the foreseeable future. Their expansion, however, has caused a stir among the large, traditional shrimpers who claim that ponds prevent the shrimp from migrating back into the ocean where an important part of the reproduction process takes place and thereby will eventually destroy shrimp fishing along the coast where they are located. But these experiments in controlled production have strong backing and it remains to be seen if the Government will do anything about them.

Iraq, USSR Establish Joint Fishing Group

Iraq and the Soviet Union have formed a joint fishing company in accordance with a fisheries cooperation protocol which Iraq ratified on 1 July 1975. The company will be known as Ar-Rafidayn Fish Company, Limited, the Iraqi News Agency reported.

Soviet-Iraq fisheries cooperation began in 1969 with an agreement signed in Moscow. The USSR promised to: 1) supply Iraq with fishing vessels, processing and storage facilities, technical aid; 2) help develop Iraqi ports; and 3) train Iraqi fishermen and technicians. A Joint Commission was also formed.

The agreement, signed at the close of the Second Session of the Joint Commission in September 1973, provided for the establishment of the joint fishing company. Iraq may also join the Persian Gulf Regional Center, a fisheries technology training center to be established in Kuwait in accordance with an agreement signed on 17 June 1975 by Kuwait, Saudi Arabia, Qatar, the United Arab Emirates, and Iran.

Mexico's 1975 Shrimp Landings Show Increase

Mexican fishermen landed 14,433 metric tons of shrimp in the first 5 months (January-May) of 1975, almost 9 percent more than the 13,242 metric tons landed during the comparable period in 1974, according to the U.S. Embassy in Mexico City. The total Mexican shrimp landings for 1975 were projected at nearly 46,000 metric tons (Table 1). About 80 percent of all Mexican shrimp landings are exported to the United States.

Table 1.—Mexican monthly shrimp landings in 1975, actual and projected, in metric tons.

Actual landings[1]		Projected landings	
January	4,403	July	1,400
February	2,940	August	1,500
March	2,472	September	4,500
April	2,318	October	10,000
May	2,300	November	6,500
June	1,617	December	6,000
Total	16,050	Total	29,900

[1]Preliminary data.

Fishery Notes

Salmon Side-Scanning Sonar Counter Tested

A new type of sonar salmon counter was recently tested by the Alaska Department of Fish and Game, Division of Commercial Fisheries, in conjunction with Bendix Corporation of California.[1] Tom Namtvedt, commercial fisheries research biologist, reported that tests were conducted over a 3-day period in the Kenai River near Soldotna where salmon counting is complicated by heavy glacial silt. Namtvedt stated that the counter was initially devised to determine the horizontal distribution of sockeye salmon smolt in streams. Initial tests with the prototype during 1974 in the Kenai River and at Kodiak indicated that the unit was also usable for counting adult salmon.

The new counter, known as the side scanner, employs one narrow-beam, horizontal-looking transducer which sends a sound through the water and "listens" for the echos made by passing fish. The echos can be recorded on magnetic tape and the image printed out on paper tape for additional analysis. The side scanner was installed in the Kenai River near the 30-transducer adult salmon counter that has been used for several years to count sockeye salmon escapement. In three 2-hour tests, a 96 percent correlation between the two independent systems was observed, giving verification to the counts made with the standard adult system. Spot checking was continued, Namtvedt said, to maintain a measure of count accuracy during the sockeye migration.

Use of the side scanner to count or verify counts of adult salmon escapement over a much wider range of situations than previously possible will enable the department to better evaluate the annual spawning population in Cook Inlet. Accurate escapement enumeration is essential to fisheries management, but before the development of sonar counters, it was not possible in large muddy rivers of the type encountered in Cook Inlet and elsewhere in Alaska.

The original 30-transducer counter is limited in its application to certain stream types and fish migration characteristics. The side scanner promises to be more adaptable and if not replacing the original sonar array will at least expand counting capability to many new river systems.

Escapement information is used in managing the fisheries to achieve the proper balance between catch and escapement to insure the productivity of future runs while giving maximum allowable benefit to the fishermen. Escapement information may also be used to forecast the size of future returns. The side-scanning unit is also being

[1]Mention of trade names does not imply endorsement of commercial products by the National Marine Fisheries Service, NOAA.

considered to replace test fishing at the mouths of rivers in Cook Inlet to more precisely regulate fisheries during the season.

The side scanner was designed and developed by Al Menin of Bendix Corporation under contract to Commercial Fisheries Division of the Alaska Department of Fish and Game. It is the product of the most recent advances in electronic technology. The usefulness of this unit has led the department to order another side scanner for application in Cook Inlet and elsewhere in the state. This unit would probably be used to evaluate smolt migrations in Bristol Bay early in the year and subsequently would be brought to Cook Inlet for use in counting adult salmon escapements. Based on this season's experience certain modifications will be built into the new counter. It will have a variable-beam width transducer and 10 individual counters. Each counter will cover 10 percent of the horizontal range of the beam. The new version will be particularly useful in streams where high water velocity or debris content precludes the use of the original 30-transducer system.

Authors, Titles, Subjects in *Marine Fisheries Review*, Vol. 37, Nos. 1-12, 1975

Indexed here by author, title, and subject are the 62 papers which appeared in *Marine Fisheries Review* in 1975. A list of these papers, in numerical order, appears at the end of the Index. Anonymous notes, news articles, and regular departments are not indexed, since they are often of preliminary or ephemeral nature. Entries are indexed by number and page (i.e., 7:12 indicates the July number, page 12).

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Marine Fisheries Review Papers, Vol. 37, Nos. 1-12, 1975

Krill Studies, Fishery Meetings, and New Fishing Charts

. . . .**A pilot krill processing plant,** designed and developed in Norway, has been installed in a Soviet research vessel, the Norwegian Information Service reports. Trial fishing will be conducted in Antarctic waters and, if successful, orders for full-scale plant versions may follow. The plant produces krill paste, dried or frozen, for both animal and human consumption. . . .

. . . .**Japan continued its krill studies in 1975,** as the Government-sponsored Marine Resources Research Center sent the trawler *Daishin Maru No. 17* to the Antarctic on a third krill industrialization cruise, *Australian Fisheries* reports. Previous expeditions were made in 1972 and 1973. Such products as krill-mixed dumplings, meat balls, tempura, and frozen cooked krill blocks have been developed. . . .

. . . .**A doubling in size of the South Carolina Marine Resources Center** complex at Fort Johnson is expected by March 1977, according to that state's Division of Marine Resources. The College of Charleston is currently building a $950,000 facility next to its Marine Biological Laboratory. Also under construction is a 32,000 square foot, $3 million addition to the state's Lunz Building for marine-related classes and research, and a 45,000 square foot, $4 million facility for the National Marine Fisheries Service's Southeast Utilization Research Center. Six small dormitories for marine science graduate students are also planned. . . .

. . . .Australia will **limit the number of bluefin tuna purse seiners** off parts of its southeastern and southern shores to vessels that fished there in 1974-75, according to *Australian Fisheries*. Vessel owners must get their licenses endorsed by the New South Wales State Fisheries and the South Australian Department of Fisheries to purse seine for bluefin tuna in the affected waters. No limits have yet been set on traditional pole and live-bait fishing. . . .

. . . .The Environmental Protection Agency (EPA) has awarded a $3.68 million contract to add 39,000 square feet to and improve its existing 20,000 square foot **National Marine Water Quality Laboratory at Narragansett,** R.I. to meet Occupational Safety and Health Act requirements. New, separate structures are planned for support services and storage of hazardous chemicals and compressed gases. The lab conducts research for development, substantiation, and updating of biological information on marine ecology, and develops water quality criteria for recreational marine waters and methods for management and monitoring of regulatory problem areas such as ocean dumping and power plant siting. . . .

. . . .**An International Conference on the Handling, Processing, and Marketing of Tropical Fish,** 5-9 July 1976, is being organized by the Tropical Products Institute, a scientific unit of England's Ministry of Overseas Development. Stressing post-harvest techniques and marketing of tropical fish, it will explore fish resources, quality control, handling and marketing of fresh and frozen fish, fish meal, processed fish, and shellfish exports. Details are available from the Tropical Products Institute, 56-62 Gray's Inn Road, London WC1X 8LU England. . . .

. . . .**Canadian fishermen are testing two prototype fisheries charts** in the Browns Bank area off southwest Nova Scotia, Environment Canada reports. Developed by Canada's Hydrographic Service, the new charts use metric contour lines and color shading to portray sea-floor features, coded numbers to indicate bottom roughness and composition, and both Loran-A and Loran-C lattices to aid electronic positioning. Chart production and/or modification will depend on the results of the tests and comments. . . .

. . . .Guidelines to **protect wetlands, marshes, and other waters from filling or dredge-spoil dumping** problems have been issued by the Environmental Protection Agency (EPA). Besides wetlands and marshes, the rules cover disposal into coastal waters, rivers and tributaries, and other water bodies. In announcing the guidelines, EPA Administrator Russell E. Train noted estimates that "60 to 80 percent of our commercial and sporting fish are directly or indirectly dependent on (wetland areas) at some point in their life cycles." Applicable disposal permits are handled by the Army Corps of Engineers under the 1972 Water Pollution Control Act. . . .

. . . .**Canada's 1975-76 Fisheries and Marine Service (FMS) budget, about Can$208 million,** would be a $21 million increase over 1974-75, reports the *Canadian Fishermen and Ocean Science*. The FMS budget now accounts for 51 percent of the entire Department of Environment budget, compared with 47 percent in 1974-75. Capital investment expenditures are estimated at $67.7 million for new research facilities, improved surveillance capabilities, and improved harbor facilities ($35 million) for small craft. . . .

. . . .**A South African marine industries exhibition,** including symposia on fisheries, marine engineering, and navigation, will be held at Cape Town, 27-30 October 1976, the NMFS Office of International Fisheries reports. The exhibition, occupying more than 3,550 square yards of the Goodwood Showgrounds, will be internationally oriented and wider in scope than the first two South African marine exhibitions. . . .

. . . .**Norway's sixth International Fisheries Fair, "Nor-Fishing '76,"** is scheduled for Trondheim, Norway, 9-15 August 1976, according to the Norwegian Information Service. Organized jointly by the Norwegian Fisheries Directorate and the Norwegian Trade Fair Organization, the event drew more than 43,000 professionals from 48 countries in 1974. . . .

. . . .**Ten Japanese mothership North Pacific high-seas salmon fleets** (in Area A, north of lat 45°N) ceased fishing on 25 July after meeting their 34,108 metric ton target according to Japanese newspaper reports. When the fleets began fishing on 21 May, stormy weather and slow warming of the waters hindered fishing; however, chum salmon fishing improved considerably in the final phase of operations. Catch composition of the fleets averaged 13 percent reds, 42 percent chums, 42 percent pinks, and 3 percent silvers and kings. . . .

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